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THE EARLIEST ENGLISHMAN

The Thinker's Library, No. 127.

THE EARLIEST ENGLISHMAN

BY

SIR ARTHUR SMITH WOODWARD

WITH A FOREWORD BY

SIR ARTHUR KEITH

LONDON:

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PREFATORY NOTE

THIS little volume was planned and talked over many years ago in response to requests from people living near Piltdown for more information about the famous skull. The opening chapter was written but laid aside for more immediate technical work. When my husband's blindness put an end to all research, I cast about to find something to give him occupation which would hold his interest and bring a degree of happiness to him. The few written pages were brought out and slowly the story grew until the last word was written the day before he died.

I should like to express my warm thanks to two old and much valued friends of my husband—to Sir Richard Gregory, Bt., F.R.S., for his help and encouragement in bringing this little book to publication, and to Sir Arthur Keith, F.R.S., for his great kindness in writing a Foreword.

My thanks are also due to the Trustees of the British Museum, through the Keeper of the Geological Department, for permission to reproduce the photographs of the pieces of the skull, and also to the Council of the Geological Society of London for permission to reproduce from their *Quarterly Journal* the section of the Piltdown gravel. Miss Tassert re-drew the illustrations.

MAUD WOODWARD.

FOREWORD

By SIR ARTHUR KEITH

My friend Sir Arthur Smith Woodward died at Hill Place, Sussex, on Saturday September 2, 1944; he had entered his eighty-first year, for he was born at Macclesfield on May 23, 1864. At the age of eighteen he became an assistant in the Geological Department of the British Museum (South Kensington) and there he laboured for forty-one years; he had been head of his Department for twenty-two years before his retirement in 1923, at the age of fifty-nine. His career was crowded with one discovery after another; how full these years were is vividly illustrated by the fact that the mere list of additions he made to the knowledge of his time occupies twenty-four pages of *The Proceedings of the Royal Society*.[1] Amidst the throng of discoveries there was one which stood out from all the others because of its humanity and because of its revelation, for it showed that the Weald of Sussex, some half-million years ago, had been the home of a strange form of humanity, one in which features of modern man were unexpectedly blended with those of the ape.

Smith Woodward was keenly alive to the fact that the discovery at Piltdown in the Weald of Sussex was, and would ever remain, a major event in the unfolding of Man's remote past, and that every incident relating

[1] An account of Sir Arthur Smith Woodward's Life and Works is given by Sir C. Forster Cooper in *The Obituary Notices of Fellows of the Royal Society*, 1945, vol. 5, p. 79.

to the discovery would retain an abiding historical value for unborn generations of mankind. Hence in the evening of his life he resolved to set down in simple words a straightforward account of the events which led up to the discovery and to explain how his mind reacted to the new facts which poured in upon him as he proceeded, and to trace, step by step, the completed picture that finally arose in his mind of Piltdown Man as a living reality. Such was the task Smith Woodward allotted to the closing years of his life. His memory remained strong and active as ever; his judgment moved freely and decisively as of old—but alas! he could no longer put his thoughts on paper; his last three years were spent in blindness. Fortunately he had in Lady Smith Woodward a companion who had shared in all his thoughts and experiences. She was born into geology, for her father—Prof. H. G. Seeley, F.R.S.—was one of the greatest students of fossil forms of his time, and when in 1894 she wedded Arthur Smith Woodward she may be said to have married into Geology. It was in the last three years of his life that he dictated, and Lady Smith Woodward wrote down, the reminiscences which make up the text of this book—*The Earliest Englishman*. Here, then, is a record of fact which will continue to be read as long as Englishmen love the land of their birth; for many a century to come experts, seeking to unravel the complicated problem of human origins, will find inspiration in its pages. It is a book full of thought, the right stuff to form a volume in The Thinker's Library.

There are but few alive now who took part in that crowded, excited meeting of the Geological Society in the autumn of 1912 when Charles Dawson and

Smith Woodward gave their first account of their discovery at Piltdown. Charles Dawson, the chief of the Piltdown band, was the first to go. He died in 1916 at the age of fifty-two. In these pages Smith Woodward does Dawson full justice. My heart went out to Charles Dawson, the scholarly country solicitor; as long as England can produce such men, her place in the Society of Nations is assured. Next to go was that great stalwart of Evolution—Sir E. Ray Lankester. Sir Grafton Elliot Smith was destined to follow him; then came the turn of Dr. W. P. Pycraft. With the death of Smith Woodward himself in 1944 there remain, so far as I know, only three who were intimately in touch with the contentions which arose over the earlier reconstructions of the Piltdown skull—Lady Smith Woodward, Mr. F. O. Barlow—a prince of modellers—and myself. At these earlier disputatious meetings of the Geological Society I fear I played the part of the stormy petrel. Were the earlier participants in the Piltdown strife to return now, nothing would surprise them more than to find that as time went on Smith Woodward and I, instead of drifting farther apart over the Piltdown issues, drew nearer and nearer to each other in our interpretation of the Piltdown riddle. There was a habit he and I had in common. When we came across a specimen which puzzled us we set it on a table where the light from a window caught it at all hours of the day; as we passed and re-passed the table in the course of our work a chance glance at the specimen would reveal aspects we had not seen before. He let the Piltdown specimens sink into him in this way; and so did I. If we did not reach full agreement we came by a large measure of it.

Of the various honours which have fallen to my lot none has touched me more deeply than that which Smith Woodward paid to me in the summer of 1938. He had resolved to erect a monument at Piltdown to mark the site of discovery and to keep green the memory of his friend, Charles Dawson. He invited me to unveil the monument and I gladly accepted the invitation.[1]

The Piltdown enigma is still far from a final solution. At this present moment I find Dr. Franz Weidenreich, who has won a just mead of praise for his restoration of the ancient men of Java and of China, rejecting the Piltdown fossils as authentic documents, so much are they out of keeping with his theory of human evolution.[2] On the other hand I am firmly convinced that no theory of human evolution can be regarded as satisfactory unless the revelations of Piltdown are taken into account. In amplification of this statement I may cite a recent experience of my own. In 1939, when Prof. T. D. McCown and I had finished our six years of labour on the wonderful fossil men of Mount Carmel,[3] I again spread out in front of me the Piltdown fragments, and set out to reconstruct them in the light of increased experience. I soon found myself involved in all the puzzles which I had encountered a quarter of a century earlier. The mistake I had been making all along I found to be this: I shared the common idea that the earlier the type of man, then the more symmetrical would be the right

[1] Readers will find an account of the unveiling ceremony in the issue of *Nature* for July 30, 1938.

[2] Dr. Franz Weidenreich, *Palaeontologica Sinica*, 1943, No. 127, p. 216.

[3] McCown and Keith, *The Stone Age of Mount Carmel*, Vol. 2, 1939.

and left halves of the hemispheres of his brain. It was not till I realized that in Piltdown Man the left hemisphere dominated the right, both in size and complexity, that discrepant parts fell into their appropriate places.[1] The specialization of the left half of man's brain at so early a date took me by surprise. How many other surprises may be in store for us before we reach a final settlement? So dominant is the left hemisphere in modern man that the right half has been removed and yet men and women who have had this Herculean operation performed on them have been able to earn a livelihood as before.[2]

[1] Keith, Sir A., *Jour. Anat.*, 1939, 73, pp. 155, 234.
[2] Dr. Walter E. Danby, *Johns Hopkins Hospital Bulletin*, Aug. 24, 1946.

"Science has its own peculiar terms, and, so to speak, its idioms of language; and these it would be unwise, were it even possible, to relinquish; but everything that tends to clothe it in a strange and repulsive garb, and especially everything that assumes an unnecessary guise of profundity and obscurity, should be sacrificed without mercy."

SIR JOHN HERSCHEL.

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INTRODUCTION

EVER since man began to think about his origin and place in the world, two opposite opinions about these have been held and disputed. Some have supposed that he first appeared in a high state of perfection, which he afterwards lost; while others have maintained that his earliest condition was little better than that of the animals among which he lived, and that his capacity for civilization was only gradually acquired. On the first supposition he was a mysterious arrival beginning a new order of things in a world already prepared for him. In the second case, while his rise to a commanding position was no less mysterious, he was at least naturally related to the rest of the animal kingdom, excelling only in the capabilities of his brain.

All nations in the beginning were inclined to glorify their origin and regard their founders as akin to gods rather than to ordinary men. Most of them also reasonably supposed that their foundation coincided with the first peopling of the earth. They therefore favoured the theory that man arose endowed with his highest faculties, and lived in a kind of Golden Age such as was described by the old Greek poet Hesiod (850 B.C.) and by the later Roman poet Ovid (43 B.C.–A.D. 18). Even so early as the flourishing period of Chaldæa this was the popular belief, and it has survived in various forms, especially in dogmatic theology. In the Pentateuch it occurs in a

modified version, which admits that, whatever may have been man's higher nature, he was at first ignorant of so everyday a necessity as the use of metals, which only came later, in the days of Tubal Cain.

The second supposition—that man slowly progressed from a state little better than that of an animal—seems always to have been favoured by those who specially observed and thought about the natural world around them. It was maintained by Critias so long ago as the time of Socrates (between 500 and 400 B.C.), and it is admirably put by the Roman poet Lucretius (95–51 B.C.) in his work on *The Nature of Things* :—

> Hands, nails and teeth, man's earliest aims,
> And stones and broken boughs of trees,
> Then flames and fire he next found out
> And later learnt the strength of iron and bronze.
> But bronze was known the first
> Since it easier melts and more abounds.

Horace (65–8 B.C.) follows Lucretius, and refers especially to caverns as the first shelters used by man.

Until late in the seventeenth century there appeared to be no means of verifying either of these opinions. They could be discussed merely on the basis of tradition and probability, without any definite reference to facts. So late as 1778, indeed, Dr. Samuel Johnson ridiculed the idea that anything could be really known about the state of man before the dawn of history. In 1666, however, Sir William Dugdale thought he had proof, from discoveries in Warwickshire, that the ancient Britons were at first ignorant of brass and iron and used only weapons of stone. In 1699 a beginning was also made in comparing the bodily structure of man with that of the animals most nearly similar to him to discover

whether there was any real relationship. Dr. Edward Tyson, an anatomist who had dissected many animals, obtained the body of a young chimpanzee, which he dissected and described in a work entitled *Orang-outang, "Sive Homo Sylvestris"; or, The Anatomy of a Pygmie compared with that of a Monkey, an Ape, and a Man.* Thus facts at last supported the conclusion that man began with the simplest possible kind of life, and might indeed have evolved from the apes which so nearly resembled him in the construction of their bodies.

In the first year of the nineteenth century the problem began to be studied more scientifically, when John Frere recognized stone tools, which had been roughly shaped by man, in a brick-pit at Hoxne, near Diss in Norfolk. He felt sure, from the position in which these tools were found, that they were made by men who lived in England when the shape of the surface of the country was very different from that in modern times. Men therefore used stone for the making of tools, which they would have made from metal if it had already been known to them. Discoveries of the same kind multiplied in England, France, and Belgium during the first half of the nineteenth century, and it became evident in subsequent years that, at least in Western Europe, man began his career as a lowly savage, gradually progressing in course of time to the dawn of civilization. In 1856 the skeleton of one of these men was found by workmen in a cave in the Neander valley (or Neanderthal) near Düsseldorf, in Germany, and the portions of it which were preserved showed that it bore more resemblance to the skeleton of an ape than does that of any existing man. In later years portions of many

nearly similar skeletons have been dug up, not only in Europe, but also in Asia, and the idea that the earliest men were more ape-like than existing men has become securely based on facts.

In England, although the handiwork of prehistoric man clearly showed that he had progressed from the age of rude stone tools to the fashioning of more varied tools both of stone and of bone, it was not until 1912 that any portion of the skeleton of one of the earliest of these men was discovered. In that year Mr. Charles Dawson found the greater part of the skull of such a man in river gravel at Piltdown, in Sussex. The story of this discovery is told in the following pages.

CHAPTER I

THE STORY OF THE DISCOVERY

CHARLES DAWSON was one of those restless people, of inquiring mind, who take a curious interest in everything round them—from an unusual form of ancient rushlight-holder to the latest device in electric torches; from an old parchment deed to a horn-like growth on a horse's head; from the proverbial live toad in stone to an escape of inflammable gas from the ground; from fossils and minerals in the Wealden rocks to the tools and other leavings of prehistoric man. Nothing came amiss to his alert observation. When I first met him, in 1884, he lived at Hastings (St. Leonards) and was collecting fossil-bones of extinct reptiles from the quarries in the Wealden sandstone round the town, and his collection was soon important enough to be accepted by the British Museum. He always took care, indeed, to submit his discoveries to experts, who discussed them and stimulated him to further exertions. He was a solicitor by profession, but during his leisure he lived in the world of scholars who were engaged in research.

It was while performing one of his professional duties that Mr. Dawson was led to discover the fossil human skull at Piltdown. He was steward of the manor of Barkham, Sussex, which included Piltdown, and as such he had to preside over the periodical Court Baron which was held at Barkham Manor House. One day when attending this Court, about the begin-

ning of the present century, he noticed in the gravel on the farm road some peculiar brown flints, which reminded him of others he had seen in an old bed of clay on the top of the chalk in the North Downs in Kent. Such flints had not been recorded in the neighbourhood of Piltdown by the scientific men who had written about that district. Mr. Dawson was therefore much surprised to learn from the farmer, Mr. Robert Kenward, that the gravel with the flints was actually dug on the spot and had been dug on the farm from times immemorial. Two labourers were busy at that moment in a little roadside pit still getting gravel for local needs, and Mr. Dawson eagerly awaited an interval in the Court's proceedings to go and talk to them. He saw at once that the gravel was a shingle bank swept to the place by a river, which had either disappeared or changed its course. As a geologist, he knew from the position of the gravel that it dated back to a time ages before written history. Some of the brown flints on the North Downs had almost certainly been chipped and used as tools by men who lived in the same uncivilized way as the lowest of present-day savages. The Piltdown gravel with flints, on Barkham Manor farm, was therefore well worth watching because it might contain the remains of man and animals which no longer lived in Europe, and perhaps no longer survived in any part of the world. Mr. Dawson accordingly asked the labourers to look out for bones or teeth or anything strange, saying that he would call again to collect their finds and give them a suitable reward.

The men worked the gravel only at intervals when it happened to be wanted, and Mr. Dawson paid several visits to the pit in vain. One day at last,

however, the men dug up what they thought was a coco-nut, and they felt sure that this was the kind of thing which would please their curious and presumably generous friend. They could scarcely doubt that it was a coco-nut because it was rounded and brown and of the right thickness, with the inside marked in the usual way by branching lines and grooves. It seemed a familiar and common object, but, as it was a little bulky to keep, they broke it with a shovel and threw away all but one piece, which they put in a waistcoat pocket to show to Mr. Dawson on the first opportunity. When he came round again, the men produced their find and described to him the "coco-nut" from which they had broken it. They showed him the place where they had found it, and told him that the pieces which they had thrown away were in the heaps of rubbish around. Mr. Dawson recognized at once that the supposed coco-nut was really a human skull of unusual thickness and texture, which had been hardened and stained brown by oxide of iron in the gravel. He did not show any excitement or concern about the misfortune that had happened to the unique fossil, but he patiently waited for a favourable occasion to examine the pit and see whether the labourers' story was true.

Time after time Mr. Dawson visited the spot and searched the rain-washed heaps of gravel, but it was not until a few years had elapsed that he found a second piece of the skull, which fitted exactly one broken edge of the fragment which the men had given to him. Renewed search eventually unearthed a third piece which fitted the other two, and then came two more separate pieces which certainly belonged to the same skull. The men's story was thus confirmed,

and it was evidently desirable to dig up and sift all the gravel which still remained in and around the pit.

It was now the spring of 1912, and Mr. Dawson brought his discoveries to me to talk about them and to learn whether his conclusions were justifiable. We had often worked together in extricating fossils from the Wealden rocks near Hastings. Indeed, we had just collected for the British Museum the best known specimen of the ganoid fish, *Lepidotus mantelli*, and a fine pelvis of the dinosaur *Iguanodon*. We decided to work together again in the gravel pit on Barkham Manor farm at Piltdown, and try to find the remaining pieces of the new human skull. We also hoped to find other fossils because Mr. Dawson had already picked up flint tools and teeth of hippopotamus and elephant in the same deposit. We felt a little impatient because we had to wait until the end of May before the pit was dry enough for us to dig to the bottom of the gravel.

We were both well occupied with ordinary duties during the week, so we could devote only our week-ends and occasional holidays to the task. It was, however, probably an advantage to work only at intervals for short periods, because the discovery of bones and teeth, all stained brown, in a dark-coloured gravel, which was full of bits of ironstone and brown flints, needed very close and slow examination of every fragment. We could not employ more than one labourer to do the heavy work of digging because every spadeful had to be watched, and generally passed through a sieve. It was necessary also to crawl over the spoil heaps each time that the rain washed the particles of gravel and made them more easy to examine. We spread the gravel as much as

possible, so that, if there were rain between our visits, it could be well washed in readiness for our return.

At first we had only one helper, Father P. Teilhard de Chardin, a young French priest who was then studying at the Jesuit College near Hastings. Mr. Dawson had made his acquaintance in a curious way. Father Teilhard and a fellow-student, Father F. Pelletier, were much interested in fossils, and when they were out for recreation they regularly visited the quarries near Hastings to search the Wealden rocks. The workmen in these quarries received rewards from Mr. Dawson for any fossils which they noticed and kept for him; they received nothing from the young French priests, who would themselves pick up and take away any fossils which they found of interest. The workmen told Mr. Dawson that there were poachers in his field and complained to him that these visitors never gave any "tips." If it was his wish, they would be glad to prevent the young Frenchmen from entering the quarries. Mr. Dawson, with characteristic generosity and scientific zeal, replied that the workmen should rather welcome his fellow-collectors, and he himself would give them the "tips" of which they felt deprived. At the same time he asked about the customary days and hours of the Frenchmen's visits, and soon made an opportunity to meet them in the quarries. Thus began Mr. Dawson's friendship with Father Teilhard, and thus originated the invitation to come and help at Piltdown.

Both the landowner and the farmer had given Mr. Dawson permission to explore the gravel pit at Barkham Manor without knowing precisely what was his object. He had merely expressed interest in the brown flints found there. The eagerness with which

we all dug and sifted gravel during the first week-end therefore excited much interest and curiosity in the neighbourhood. The police were informed, and on the following Monday morning the local constable appeared at Mr. Dawson's office in Uckfield (where he was Clerk to the Magistrates), stating that he had a report to make. Mr. Dawson, as usual in such cases, admitted the constable, and was surprised to learn from him that " three toffs, two of them from London, had been digging like mad in the gravel pit at Barkham, and nobody could make out what they were up to." Mr. Dawson's embarrassment may be imagined, but he remained calm and quietly explained to the constable that there were interesting flints in the neighbourhood, and perhaps the men he reported were merely harmless seekers after these flints. He then showed some of the local flints to the constable, explained their interest, and asked him to look out and report any that he might find in certain parts of his beat. Thus ended an episode which was as comic as it was intended to be serious. Until the winter we continued our digging in peace, and we met with enough success to publish the first account of our discoveries, in December, 1912.

In one heap of soft material rejected by the workmen we found three pieces of the right parietal bone of the human skull—one piece on each of three successive days. These fragments fitted together perfectly, and so had evidently not been disturbed since they were thrown away. After much inspection, which prevented my discarding it as a piece of ironstone, I found in another heap an important fragment which fitted the broken edge of the occipital bone and gave us the line to contact with the left parietal bone.

Finally, on a warm evening after an afternoon's vain search, Mr. Dawson was exploring some untouched remnants of the original gravel at the bottom of the pit, when we both saw half of the human lower jaw fly out in front of the pick-shaped end of the hammer which he was using. Thus was recovered the most remarkable portion of the fossil which we were collecting. It had evidently been missed by the workmen because the little patch of gravel in which it occurred was covered with water at the time of year when they reached it. On different days we also picked up three undoubted flint implements, besides several "eoliths" and fragments of a tooth of an elephant, teeth of a beaver, and one much-rolled bit of the tooth of a mastodon—the first to be discovered in a river gravel in Europe. On the surface of the adjacent field we found a piece of antler of a red deer (or stag) and a tooth of a horse, both fossilized, which we supposed had been thrown over the hedge by the workmen.

In the following season—1913—we continued to work without much success until Saturday, August 30th, when we were accompanied by Father Teilhard. For some time we had been making an intensive search for the missing teeth of the lower jaw round the spot where the half of this jaw was found. We had washed and sieved much of the gravel, and had spread it for examination after washing by rain. We were then excavating a rather deep and hot trench in which Father Teilhard, in black clothing, was especially energetic; and, as we thought he seemed a little exhausted, we suggested that he should leave us to do the hard labour for a time while he had comparative rest in searching the rain-washed spread gravel. Very

soon he exclaimed that he had picked up the missing canine tooth, but we were incredulous, and told him we had already seen several bits of ironstone, which looked like teeth, on the spot where he stood. He insisted, however, that he was not deceived, so we both left our digging to go and verify his discovery. There could be no doubt about it, and we all spent the rest of that day until dusk crawling over the gravel in the vain quest for more.

Another interesting discovery was made by Mr. Dawson, who uncovered and noticed the two nasal bones of the human skull lying in natural contact on a vertical section of the gravel close to the original spot where the workmen found the brain-case. He called me to confirm his observation, and we both hoped that the whole face was present. Mr. Dawson worked carefully with a small knife round the bones, but found nothing more until he had removed them. Underneath we saw that a fragment of the very thick turbinals was present, but unfortunately that was all.

In the season of 1914, as we worked further from the original spot, discoveries became fewer. I found another piece of molar tooth of a mastodon, and Dr. Davidson Black, of Pekin, who was with us one day, picked up part of the upper molar tooth of a rhinoceros. There were no human remains, but the most important fragment of man's handiwork was uncovered in the soil beneath part of the hedge which Mr. Kenward had allowed us to remove. It was the unique bone implement which is described on p. 44.

In subsequent seasons, and at more remote places, scarcely anything was found. One day, near the base of the gravel, I picked up a battered hammer-

stone of flint (p. 52). At a later date, when working alone, I found a typical pot-boiler (p. 51) in association with other burnt pieces of flint and fragments of charcoal.

After Mr. Dawson's death, in 1916, I was able to open a series of pits along the other side of the hedge in a field adjacent to the original pit. There I was helped at times by Professor (afterwards Sir Grafton) Elliot Smith, Prof. W. T. Gordon, Prof. Barclay Smith, and others. We began close to the spot where the skull was found, and worked in both directions from this place. Progress was slow because the overlying loam was deeper than that on the other side of the hedge, though the gravel was not reduced in thickness. Our efforts, however, were all in vain. We found nothing of interest in the gravel, and it was evident that we were outside the range of the eddy which brought the scientific treasure to its resting-place. In later years the new owner of Barkham Manor, Mr. David Kerr, dug some of the gravel at a spot nearer the farmyard, and allowed me to watch the labourers at work. It was there that I found the pot-boiler already mentioned.

CHAPTER II

THE PILTDOWN GRAVEL AND ITS FLINTS

To understand why the flints so much interested Mr. Dawson it is necessary to consider the geographical position of the Piltdown gravel. It is spread over a considerable area in the basin of the Sussex river Ouse—that is, the country drained by this river—and the gravel was doubtless deposited by the Ouse long before it flowed in its present bed. Piltdown itself lies between Uckfield on the east and Newick on the west, about halfway between Forest Row on the north and Lewes on the south. It is therefore in the Weald—the Andreaswald of the Saxons, the Anderida Forest of the Romans—which occupies the greater part of Sussex, Surrey, and Kent between the east-to-west ranges of hills known as the North and South Downs.

The rocks of the Weald are clays, sands, and sandstones, with much ironstone, but no flint and scarcely any limestone. Therefore the Sussex Ouse and the other rivers of this part of England which rise in the Weald can only collect clay and sand and bits of sandstone and ironstone to carry along in the stream when they wear away the bedrock of the country through which they run. A geologist notices, however, that the rocks of the Weald at their northern and southern edges do not end there, but are overlapped by the Chalk, which forms the North and South Downs—

that is, they pass under the Chalk—and there can be no doubt that untold thousands of years ago, just before man appeared in this part of the world, the Chalk completely covered the Weald. Rains and rivers have washed it away bit by bit to the sea, leaving only the bordering rims of Chalk called the Downs. The removal began along the middle east-to-west ridge of the Chalk covering the Weald which was then, as now, the highest part of this country, and it proceeded both northwards and southwards to the present limits of the Chalk in the Downs. This explanation can be better understood by reference to the diagrammatic section which geologists draw across the Weald from the North Downs to the South Downs (Fig. 1). Now certain layers of the Chalk are full of flints, which are such hard and heavy lumps that, when the surrounding soft rock is destroyed by weathering and removed by the rivers, they are often left behind as a kind of residue. Large patches of them, covered only by blown dust, actually remain on the surface of the Weald, close to the Downs, just as they were left in comparatively modern geological times. They are seen, for example, on the farm connected with the Priory on the edge of Ditchling Common. Those flints, which were left lying on the surface in the middle part of the Weald when the complete removal of the Chalk began, would eventually find their way into the rivers which rose there, and thus would be mixed with the gravel which those rivers washed together.

While the surface of the country was worn down and the rivers removed the loose material, various patches of gravel, sand, and mud were deposited on each of the successively lower levels. These deposits were often

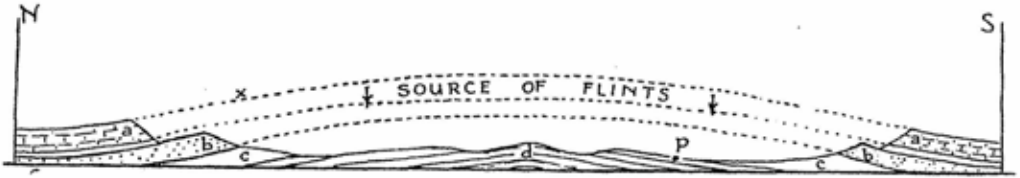


FIG. 1.—Geological section across the Weald from the North Downs to the South Downs, showing the layers of rock bent into an arch of which the central portion has been weathered and washed away by rivers. The parts of the layers which have been removed are indicated by dotted lines. *a*, Chalk, the upper part containing flints which fall on the surface below, as indicated by arrows, when the surrounding chalky material is washed away; *b*, Upper and Lower Greensand, with Gault between; *c*, Weald Clay, the upper part of the Wealden Formation; *d*, Hastings Sands, etc., forming the middle part of the Weald; P, Position of Piltdown; ×, Region of the original surface of the Chalk, where the men who made the eoliths lived (according to Sir Joseph Prestwich).

washed away again, and the almost indestructible flints were transferred from one gravel to another, always to a lower level, in the direction of the sea. The Piltdown gravel, as recognized by Mr. Dawson, is part of one of these deposits which has escaped destruction. The flints contained in it have not progressed far in their course towards the sea, so it must have been formed not long after that part of the country had been uncovered by the removal of the overlying Chalk. The gravel rests on an old land surface over which the Ouse used to flow, but which is now from 60 to 80 feet above the level of the existing river. Since the gravel was left behind, indeed, the Ouse has cut out and deepened the whole length of its valley seawards to a depth of 60 to 80 feet.

There are, of course, no means of deciding how many years or centuries have elapsed since this final deepening of the Ouse valley began. A geologist would say that the period might be reckoned in thousands of years, rather than in hundreds. The actual deepening may have been comparatively rapid, and may have needed only a small fraction of this time, because it was caused by a change in the height of the land above sea-level. A geological study of the valleys occupied by the present rivers of S.E. England shows that, during the thousands of years just before the dawn of history, this part of Europe was less stable than it has been during historic times. There were several small up-and-down movements of the land above sea-level, which are recorded in the alternate deepening and partial silting-up of the valleys. The record is especially clear in the valley of the Thames, where an old land surface, the so-called

High Terrace, 80 feet above the present level of the river, seems to correspond with the surface in the Weald on which the Piltdown gravel rests. In the gravels and brick-earth left stranded on the High Terrace of the Thames, as for example at Swanscombe on the Kentish side, there are bones and teeth of large quadrupeds such as the elephant, rhinoceros, and hippopotamus, which evidently indicate that Britain at the time was directly connected with the continent of Europe. The Straits of Dover had not been formed, and a large part of the bed of the North Sea and the English Channel was dry land. The Thames was merely a tributary of a larger river which flowed northwards along the plain which is now covered by the North Sea: the river deposits on the bed of the North Sea are full of bones of elephants and other animals, which are often dredged up by fishermen. The Sussex Ouse was the tributary of another river which flowed westwards along the bed of what is now the English Channel. Such was the geography of this extension of Western Europe when Piltdown Man lived here.

When we first began to dig at Piltdown, Mr. Dawson and I thought that the gravel deposit itself probably represented a long period of time. We distinguished three layers which probably differed considerably in geological age (Fig. 2). At the top there seemed to be a yellow sandy and clayey layer with some flints. Below this lay the dark-brown gravel, which was cemented into a hard mass by oxide of iron and contained the human skull and lower jaw, besides various animal remains. At the bottom were a few inches of yellow mud, resting on the Wealden bedrock, containing large flints and some bits

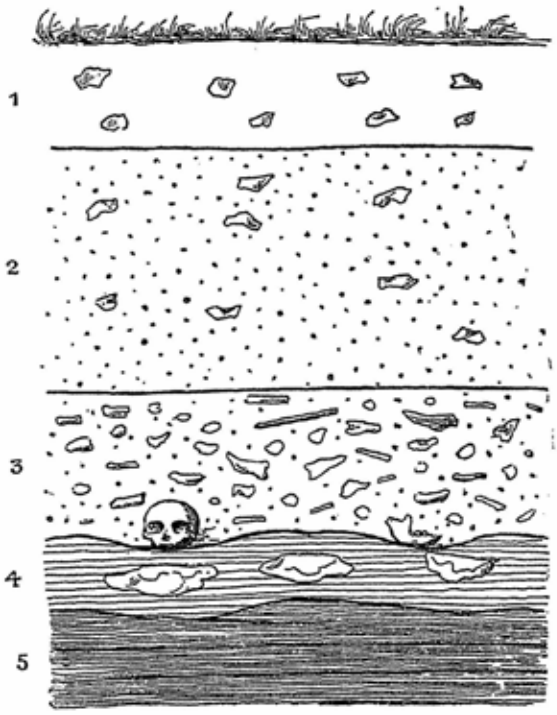


FIG. 2.—Section of gravel-bed at Piltdown, Sussex, according to Charles Dawson. *1*, Surface soil containing various flints, including Mesolithic and Neolithic tools, also primitive pottery; *2*, Pale yellow sandy loam with small patches of dark iron-stained gravel; *3*, The main part of the Piltdown gravel, darkly stained by oxide of iron, and containing the human skull and lower jaw and various animal remains; *4*, Yellow sandy clay about 8 inches thick, containing large weathered flints and the bone implement (Fig. 11). (From the *Quarterly Journal of the Geological Society*, 1914.)

of sandstone, with fragments of bone and probably the bone implement which I shall describe later (p. 44). Wider experience of the gravel, however, led us to conclude that it was a flood deposit which might have been formed during a single storm. It varies in thickness from about 2 to 7 feet above the muddy basement layer, and the hard and soft, dark and light layers are very irregular in their distribution. Big flints and pieces of sandstone and ironstone are scattered among the finer material, and they are especially numerous at the bottom. In the basement mud the flints are very much weathered, and most of them are shaped rather like potatoes. They must have been lying loose on the surface of the ground for a long time before they were swept into the river. When the stones are of elongated shape they lie with their long axis vertical or much inclined, as if they had been suddenly dropped by the checking of the strong current which hurried them along. As we found no fossils in the pit far from the original spot, we thought that the skull and other remains must have been brought together in an eddy. There are often floods, of course, in the valleys of the Weald in the winter-time to-day, but they must have been much greater in the conditions under which Piltdown Man lived here.

As might be expected, most of the stones in the gravel are fragments of the Wealden rocks, and a large proportion of them are bits of ironstone. These are dark brown or even black in colour and often assume fantastic shapes. This ironstone originally filled cracks in the Wealden sandstone, and when the rock was broken up by weathering and running water the shape of the resulting pieces depended on the form and arrangement of the cracks which they

had filled. Many are so much like broken fossil teeth and bones that they are very deceptive, and their true nature can be seen only after they have been thoroughly cleaned from the surrounding clay. In contrast to the dark stones just described there are occasionally rounded pebbles of white quartz. These must have been originally rolled on a sea beach, and Mr. Dawson thought that they came from the destruction of the so-called Lower Greensand which is now seen on the edge of the Wealden country, between this and the overlying Chalk.

The flints in the gravel are of very varied shape and size, and in nearly all of them the sharp edges have been rounded by rolling in the stream. Most of the flakes seem to have been formed by the exposure of the flints to the weather, and their surface is often marked by shallow rounded pits which are best explained by supposing that these little flakes were removed by the freezing and expansion of penetrating water when they lay on the ground. Six of these pits are well seen on the surface of the flint represented in Fig. 3, D.

The flints are observed to be of two kinds. Those in the basement mud already mentioned and a few in the brown gravel itself are from the layers of "nodular" flints which are arranged in beds in the Chalk. The majority of the flints in the gravel, however, are pieces of "tabular" flint, which occurs in thin layers in the Chalk. These flat pieces are especially interesting because they often appear as if they had been shaped by man to make effective scraping, cutting, or piercing tools. Indeed, as noticed by Mr. Dawson, they are similar to the eoliths which have been described as man's handiwork from surface deposits on the North Downs (Fig. 3,

E and F). If they have been worked and used by man, they show that man was already living on the top of the Chalk long before it had been washed away

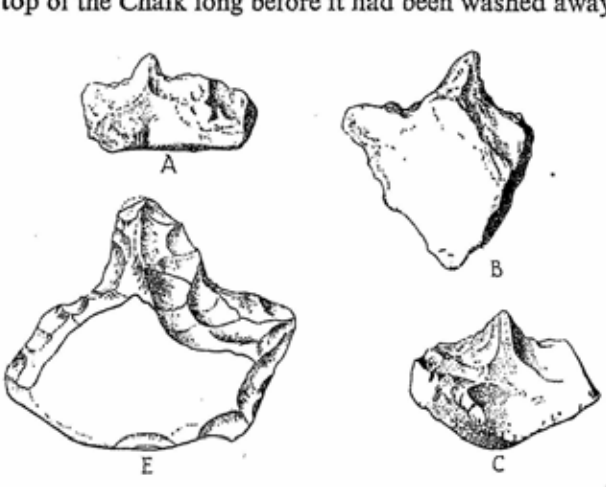


FIG. 3.—Eoliths, or pieces of tabular flint, which may have been chipped and shaped by primitive men. A–C, From the Piltdown gravel, all chipped to a point; D, From the Piltdown gravel, hollowed, perhaps for a scraper, and marked by rounded pits probably produced by freezing of water which penetrated cracks; E–F, From the surface of the North Downs, Kent, resembling two from Piltdown, C and D.

to the present extent. These so-called eoliths in the Piltdown gravel may actually have been derived from the same source as those still lying on the North

Downs (Fig. 3). It has, however, long been known that "tabular" flint has a hexagonal structure—that is, it tends to break along the edges of six-sided pieces. The shape of some of the eoliths may therefore be due to natural breaking of the flint while tossed about in a stream. To illustrate this possibility Mr. Dawson took some hexagonal pieces of common starch and shook them in a bag. Among the fragments thus produced he found many which were miniatures of the bits of tabular flint which are sometimes claimed as having been shaped by man. Of course, even if the flints were shaped by natural causes, those which were useful may have been selected by man, and some of the smaller chippings on them may have been made by him to improve their utility. If the chips are artificial, they must have been made by man, for not even apes and monkeys are known to fashion tools. Whatever the interpretation of these flints may be, most of those found at Piltdown are so much water-worn that their shaping must have been much earlier than the floods which brought together the gravel, and so they cannot be ascribed to Piltdown Man.

Many of the flints have again been removed and carried to a lower level nearer the sea. Some of them are still being rolled about in the bed of the existing stream, and others have been buried once more in the gravel, at the bottom of the valley, which the river has deposited during its meanderings in comparatively modern times. This newer gravel is worked at Sharpe's Bridge, about half a mile from the pit on Barkham Manor Farm, and sold under the trade name of "Piltdown Gravel." It has also been worked in many other localities, as at Isfield.

Nothing has so far been found in it, and nothing can be expected in it of earlier date than the Neolithic or New Stone Age. The present contour of the country seems to date back to the beginning of Neolithic times, for many of the rock shelters contain flint tools made by early Neolithic or Mesolithic Man. Among such shelters may be mentioned those near the rock named Big-upon-Little, in the valley between West Hoathly

FIG. 4.—Polished Neolithic axe of flint. A, Front view; B, Side view, from the loam above the Piltdown gravel.

and Ardingly, and similar shelters on the estate of Lullings, between Ardingly and Balcombe, from which Mr. Michael Holland has made a large collection of small flint tools. Similar tools are also found in the surface earth which rests upon the Piltdown gravel on Barkham Manor Farm. These include not only the smaller flints, which were chipped by the earliest Neolithic men, but also larger polished flints which were made by later tribes. The beautifully symmetrical axe-head (Fig. 4), which was found on the

other side of the hedge bounding the Piltdown gravel pit, is a fine specimen of his later handiwork.

In a general way, therefore, we may conclude that the surface of the Wealden country slopes from its central ridge downwards to the north and to the south. On this irregular sloping surface there lie various small patches of gravel which were originally deposited by rivers, but are now stranded out of reach of existing streams. The patches on the highest ground nearest to the central ridge are the oldest, while those on the lowest ground at the edge of the Weald are the newest. In the basin of the river Ouse, the gravel at Piltdown is thus the oldest of those which have been stranded during the wanderings and changes of this river. Until the discoveries of Mr. Dawson this patch had been overlooked by geologists, but it now becomes one of the most important sources of our information about the conditions of life in Britain before the final separation of these islands from the mainland of Europe. There can be little doubt that the gravel at Piltdown is of nearly the same geological age as the deposits on the High Terrace of the Thames, already mentioned, containing the bones of elephants and other large land animals which could only have travelled so far as this over continuous land. Piltdown gives us the first glimpse of the kind of man who lived here as a hunter surrounded by these animals.

CHAPTER III

THE FOSSILS OF THE PILTDOWN GRAVEL

It is not enough to know that the Piltdown gravel rests on part of an old land surface which dates back to the geological period when Britain was united for the last time with the European continent. From many discoveries we have learned that this connection lasted for a long time, during which the climate changed, animal life changed, and man showed much progress in the art of making tools. Man was here during the whole of this, the most recent geological period—the Pleistocene. For most of the time the ice of the Polar regions extended much further south than it does now, and during one period it reached even so far south as the northern edge of the Thames valley. For our part of the world, indeed, it was the Glacial Period, or Great Ice Age, and man could scarcely live further north than the fringe of the ice-covered land. The rigours of the climate probably stimulated him to make special exertions towards a more comfortable life.

It is known, however, that there were two or three intervals in this period of cold when milder conditions prevailed. The bones and teeth of quadrupeds, and the stone tools of man, buried in the High Terrace of the Thames already mentioned show that this belonged to the earliest of these intervals, when even the hippopotamus and true forest elephants flourished here. Although the corresponding fossils found in

the Piltdown gravel are so few and fragmentary, they are still enough to show that similar conditions existed in Sussex in the days of Piltdown Man. This primitive human race is therefore proved to have lived here not long after the earliest appearance of man in our part of the world. The human skull of Piltdown is thus of great interest as being one of the oldest discovered anywhere in the world. The successive divisions of the Pleistocene period now recognized by geologists and archæologists are shown in the accompanying table, and the relative position of Piltdown Man in the sequence will be readily understood.

We have already seen that some of the flints in the Piltdown gravel which look as if they had been used and perhaps partly shaped by man are so much water-worn that they must have been long rolled about in the river, and perhaps even washed out of an older gravel. They are unlikely to have been made by the race of men who lived at the time of the local flood which swept this gravel together. Other flints which are more clearly recognizable as implements are found with them, and, as these are not at all water-worn, they were probably made and lost by Piltdown Man himself.

A study of the teeth and bones of animals found in this gravel suggests that they, too, belong to two different periods of time. Some of the teeth are so much hardened by mineral substances that they shine like porcelain. They could not have been mineralized in this way if they had been buried fresh in the Piltdown gravel; they must have lain previously in a water-logged bed which held more mineral matter in solution. They were evidently washed from an older gravel, and therefore could not have belonged to

TABLE OF GEOLOGICAL AGES DURING WHICH MAN HAS LIVED IN WESTERN EUROPE

Geological period.	Aged named after nature of tools.	Special characteristics.	Species of man.
HOLOCENE, including modern times	Historic		Modern Man
	Iron Age	Tools of iron gradually replacing those of bronze and eventually superseding them.	
	Bronze Age	Beginning with a few tools of copper, later tools of bronze, in the end completely replacing those of stone. Baked pottery made on a wheel.	
	NEW STONE AGE (NEOLITHIC)	Varied and finely worked stone tools, eventually often polished and used in handles. Sun-dried hand-moulded pottery. Beginning of domesticated animals and cultivated crops.	
PLEISTOCENE, including the GREAT ICE AGE	MIDDLE STONE AGE (MESOLITHIC)	Very small stone tools, chipped, not polished, grouped in wooden handles; also chipped stone axes.	
	OLD STONE AGE (PALÆOLITHIC)	Stone tools only chipped, never polished, and used without handles. A few tools of bone and wood. No pottery. No domesticated animals or cultivated crops.	
	Magdalenian Solutrian Aurignacian	Beginning of Art; drawings and rude paintings and occasional sculptures of wild animals and men.	
	Mousterian	Beginning of intentional human burials. Probably also cannibalism.	Neanderthal Man
	Acheulian Clactonian Chellean	Stone tools, usually heavy and little varied in shape, made mainly by direct chipping, not by pressure. Tools of bone and wood rare. No intentional burials known.	Swanscombe Man Heidelberg Man Piltdown Man
PLIOCENE	DAWN STONE AGE (EOLITHIC)	Convenient pieces of stone selected and slightly chipped for use as tools.	Unknown

animals which lived when the Piltdown flood occurred. Others, though fragmentary and broken, are much less mineralized—in fact, only stained by oxide of iron—and must therefore represent animals which lived at the time when the gravel was laid down. As the human skull and the portion of lower jaw were lying close together, and are scarcely water-worn, they also seem to be of the same age as the Piltdown flood. The second set of teeth and bones, therefore, are to be considered as remains of those animals which lived with Piltdown Man.

To begin with the fossils which have been washed from an older deposit, we may first consider the two grinding teeth of a small rhinoceros. I found one of them, and Dr. Davidson Black (who afterwards named and described the Chinese fossil man *Sinanthropus*) found the second. They are both rather broken, but are sufficient for comparison with other English fossils which are better preserved. They represent a much smaller animal than any rhinoceros of which remains have hitherto been found in the British river gravels. They are in fact identical in shape, size, and mineralization with certain teeth of rhinoceros found in a peculiar deposit in East Anglia known as the Red Crag. This deposit, though now restricted to the Eastern Counties, almost certainly spread originally as far west as Sussex. Here it was washed away from the surface by rain and rivers, and the Piltdown teeth must be regarded as small relics of it. The teeth from the Red Crag belong to a species which was named *Rhinoceros etruscus* when it was first discovered as a fossil in the old country of Etruria, in Italy.

Broken pieces of another kind of tooth, in the same

state of mineralization as those of the rhinoceros just described, also occur in the Piltdown gravel. These are pieces of a crushing and grinding tooth of a small primitive elephant named *Mastodon* (nipple-tooth), which is known to have lived in Western Europe during the Pliocene period, just before the appearance of man. This form of grinding tooth differs from that of the modern elephant in being adapted for feeding on soft and juicy vegetation instead of on hard scrub. The crown of each tooth consists of nipple-shaped bosses arranged in a few cross-ridges which are covered with a very thick enamel. They would thus be as useful for crushing as for grinding. I found two pieces of one of these teeth in the Piltdown gravel, the first a single boss, the second, a piece of a ridge showing three bosses. When I found the first fragment I was so surprised that I thought it must be a bit of ironstone of imitative shape, for no remains of *Mastodon* had ever been met with in a river gravel in Europe. It was only after well cleaning the fragment that its nature could no longer be doubted. The second specimen, confirming the discovery, was not found until some months later. It is interesting to notice that teeth of *Mastodon* also occur in the Red Crag already mentioned, and among them there is one kind of tooth with which the fragments from Piltdown agree exactly. This kind of tooth was first found in a Pliocene deposit in the Auvergne, France, and the species to which it belongs is therefore named *Mastodon auvernensis.* This species seems generally to have accompanied the small *Rhinoceros etruscus*, for the two are found together, not only in the Red Crag of England, but also in a corresponding geological formation in Italy.

Three little pieces of another kind of grinding tooth of a primitive elephant, found by Mr. Dawson, seem to be less mineralized than those already described, but there is not much doubt that they also were washed out of the Red Crag. They belong to a kind of tooth which the very earliest true elephants are known to have possessed before any of them began to feed on hard and dry plants. This tooth is quite different from the deep grinders of the elephants which lived at the same time as the earliest men. If we compare our fragments with the corresponding grinding tooth of *Elephas planifrons* (the elephant with the flat forehead), it will be clearly seen that there is no difference between them. This elephant is found in Pliocene deposits ranging from India, and perhaps even from China, to Western Europe, including the Red Crag.

Whatever be the geological age of the pieces of teeth already described, there is no doubt that some kind of elephant existed with Piltdown Man because he made a remarkable tool from the thigh-bone of one of them. This tool must have been cut when the bone was fresh, and it is not so much mineralized as the teeth discussed above, being in fact rather fragile and only stained with oxide of iron. It is described on p. 44. The thigh-bone from which it was taken must have been nearly 5 feet in length, and would therefore belong to an enormous elephant, much bigger than the ordinary mammoth (*Elephas primigenius*) which lived in the later part of the Pleistocene period (the Great Ice Age). So far as is known, all these large elephants in Western Europe lived in forests and scrub at the end of the Pliocene and the beginning of the Pleistocene period. Their teeth are

powerful grinders, but the deep plates composing them are less compressed and are adapted for more juicy food than those of the mammoth. The best-known skeletons are those of *Elephas meridionalis* from France, in the National Museum of Natural History, Paris, and of *Elephas antiquus* from Rochester, Kent, in the British Museum (Natural History). Both these species are known to have lived in various parts of southern England at the beginning of the Pleistocene period, and some teeth of *Elephas antiquus* have actually been found with those of hippopotamus in an old surface deposit at Eastbourne, in Sussex, about 18 miles from Piltdown. Here the teeth are associated with those of *Rhinoceros hemitæchus*, horse, bison, and the giant Irish deer (*Megaceros hibernicus*). Photographs of these fossil teeth are published in my article on local geology in a small handbook, *The Book of Eastbourne* (Baskerville Press, Eastbourne), 1931.

There is also evidence in the Piltdown gravel of another animal, which in its wild state usually lived in well-forested country. This is the base of the antler of a red-deer or stag, *Cervus elaphus*, as little mineralized by oxide of iron as the bone implement just mentioned. This deer is already known to have been abundant, and often of large size, in Western Europe throughout the Pleistocene period. There is nothing unusual about the Piltdown fragment, which belongs to an animal of only moderate size. Part of a leg-bone of a similar deer was also found in the Piltdown gravel (see p. 51).

Perhaps the most interesting of the animal remains are two teeth of hippopotamus (Fig. 5), which have already been mentioned as having been found by Mr.

Dawson during his early examination of the gravel pit. These teeth are less mineralized than those of the rhinoceros and mastodon, and therefore probably represent an animal which lived at the same time as Piltdown Man. They seem to belong to one and the

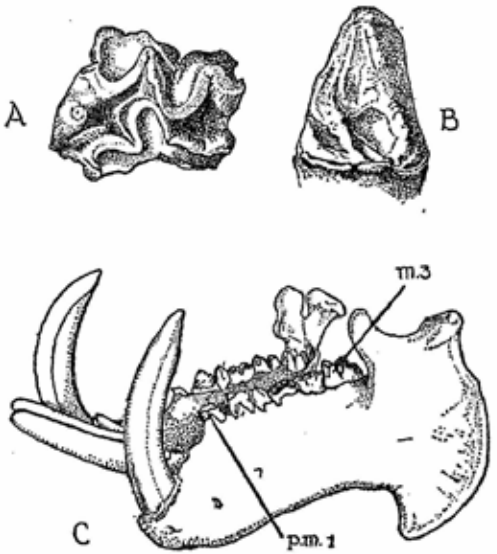


FIG. 5.—*Hippopotamus amphibius*. A, Portion of the third lower molar tooth from the Piltdown gravel, crown view; B, First lower pre-molar tooth from the Piltdown gravel, side view; C, Upper view of lower jaw of a modern hippopotamus. (*After* S. H. Reynolds.)

same lower jaw, and cannot be distinguished from the corresponding teeth of an ordinary African hippopotamus (*Hippopotamus amphibius*). This animal is already known, by many discoveries, to have lived during the early part of the Pleistocene period in

various districts of Britain, even as far north as Yorkshire. Numerous remains of very young individuals show that it actually bred in this country. Conditions here must have been very different from those under which it now lives in Africa, and its habits were probably not quite the same. In Western Europe there was more rain than now, and the rivers were probably larger, with frequent floods, but the winter would be cold, and much of the water must have been frozen. Sir Joseph Prestwich suggested that, instead of being naked, like the African hippopotamus, the European animal may have been covered with hair and wool in the same way as the northern elephant (mammoth) and the woolly rhinoceros, of which frozen carcases covered with the hairy skin are known from the Arctic regions. Our animal may also have been less dependent on water than the ordinary African one of to-day, for Mr. Marius Maxwell, who studied and photographed the big game of Africa, discovered a race of hippopotamus living in dry scrub, with very little access to water. He showed, therefore, that even in Africa the hippopotamus is adaptable to unusual conditions. Mr. Maxwell also observed that the hippopotamus could wallow in comparatively shallow water, and could settle down with comfort in a depth of not more than 2 feet.

Three teeth and a small piece of bone of the lower jaw of an ordinary beaver, *Castor fiber*, are very little mineralized, and are therefore of the same age as the Piltdown gravel. The jaw and teeth are identical with those of the beaver, which still lives in certain places in Northern Europe, and is common in various parts of Canada. This animal has already been found fossil more than once in association with the

hippopotamus in Europe, and it is interesting to find it again at Piltdown. The beaver may, indeed, have helped to make conditions suitable for the hippopotamus in the valleys of the smaller rivers. It is known to build dams across streams to make large pools. When beavers were introduced to the Isle of Bute, many years ago, they lived on the borders of a quite small hill torrent where they are said to have built a very large dam, making a pool 30 yards long by 12 yards wide and in some places 8 feet deep. In the early Pleistocene period, therefore, the beaver may have been a companion of some importance to the hippopotamus.

With the other animal remains we also found one upper grinding tooth of a horse which cannot be distinguished from the corresponding tooth of the ordinary horse, *Equus caballus*, of to-day. The early men of the Pleistocene period seem to have had no domestic animals, but it is known that some of them commonly fed on the wild horse. Piltdown Man may also sometimes have eaten its flesh.

Although they are small, these discoveries are enough to show that the following animals lived in this part of the Wealden country when Piltdown Man was here:—

Giant Elephant (probably *Elephas antiquus*).
Horse (*Equus caballus*).
Hippopotamus (*Hippopotamus amphibius*).
Red Deer (*Cervus elaphus*).
Beaver (*Castor fiber*).

To these may be added the following from Eastbourne:—

Small-horned Rhinoceros (*Rhinoceros hemitæchus*).

Giant Irish Deer (*Megaceros hibernicus*).

Bison (*Bison priscus*).

The country must have been well wooded, and watered by rivers which were often bounded by swamps. The climate could not have been very different from that of the present day, only perhaps with heavier rain. It was indeed a truly mild episode in the Great Ice Age, and the occurrence of the hippopotamus with the giant forest elephant confirms the supposition that this was the earliest break in the Arctic record. The Piltdown gravel is therefore shown to belong to the early part of the Pleistocene period.

CHAPTER IV

THE TOOLS OF PILTDOWN MAN

DURING the whole of the Pleistocene period the various groups of men who lived in Western Europe were merely wandering hunters. Like the existing black natives of Australia, they fed on whatever they could collect from wild nature, and had no fixed dwelling-places. They had not yet learned to domesticate animals or to cultivate crops, and they still had no knowledge of the use of metals. They made their tools of stone, bone, and wood, and so were limited in what they could do. Their stone tools were only roughly chipped, not polished, and seem to have been usually held in the hand without a separate handle. These people are therefore described as belonging to the Palæolithic (Ancient Stone) or Old Stone Age.

The stone and bone tools are often preserved, but nearly all those made of wood have decayed and disappeared. The only piece of worked wood dating back to the Pleistocene period hitherto found in England was discovered, by Mr. Hazzledene Warren, in a deposit containing remains of the giant forest elephant and hippopotamus, near Clacton-on-Sea in Essex. It is a rounded rod 15¼ inches long and 1½ inches across, with one end pointed. It might serve for several purposes, but it is interesting to speculate as to whether it can have been for twirling on a wooden base to produce fire—in fact a "fire-

drill." In the Bryant and May collection of the Science Museum, South Kensington, there is a wooden fire-drill made by modern natives of Sitka, Alaska, which is also 15¼ inches in length.

Almost all the stone tools in Western Europe are made of flint or the nearly similar substance named chert, according to the district in which they are found. At first they were chipped merely to a sharp edge and a point, without any design for a special

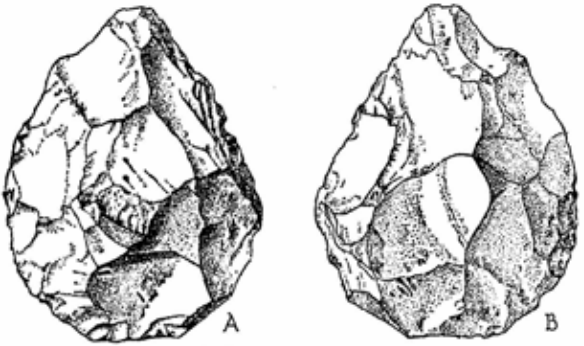


FIG. 6.—Early Palæolithic tool of chert, Acheulian style, from Sambariyeh, North Palestine. A, Front view; B, Back view.

purpose, but useful for many kinds of rough work. The earliest tools are generally little more than naturally and conveniently shaped lumps; they would be held in the hand, and thus are commonly called hand-axes. With the lapse of time man learned to chip them more skilfully, and the later hand-axes are beautifully symmetrical pieces of workmanship. A typical example of the average well-shaped hand-axe made from a lump of chert is shown in Fig. 6. It is formed by coarse chipping on

both sides, which are nearly equally trimmed. I picked it up in 1926 in a ploughed field at Sambariyeh, in northern Palestine, not far from the foot of Mount Hermon. Such tools are widely scattered over the Old World and are described as Acheulian, because they were first discovered in abundance in river gravel at St. Acheul, in the valley of the Somme, in northern France.

Piltdown Man, like some of his contemporaries in parts of the Thames valley and Essex, had advanced a little in skill and had learned that more useful tools could be made from flakes of stone rather than from lumps. In making a tool, therefore, he chipped one side of a lump of flint and then, by a hard blow, struck off the worked portion in the form of a flake. One side of the finished tool was thus nearly flat or only slightly curved. The tool was, indeed, not only better fitted for its purpose, but was also made with less labour. This style of handiwork is described as Clactonian, because it was first noticed in England in the flint tools discovered by Mr. Hazzledene Warren at Clacton, in Essex. We found four flint tools made in this way, which are sufficiently varied in shape to show how Piltdown Man worked.

The largest and heaviest tool from Piltdown (Fig. 7) is a hand-axe, 10·4 cm. (4 inches) in length, which was a little distorted because a piece of fossil shell in the flint interfered with regular chipping; the gently curved side was made by two blows, and the chipped side is only coarsely fashioned. It is thicker than most hand-axes. Another heavy tool, 14 cm. (5½ in.) in its greatest length, is nearly square, with the smooth side made by one blow, and its other side only very little worked round the edge. One corner is sharper

than the others and seems to have been used as a point. A smaller pointed triangular tool (Fig. 8) shows well the rounded base for holding, with its simple side made by two blows, and the other side very irregularly chipped. It, also, is rather thick at the

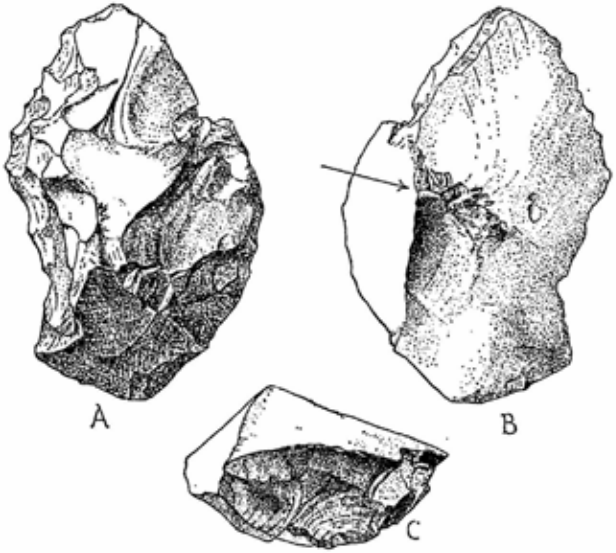


FIG. 7.—Palæolithic hand-axe from the Piltdown gravel. A, Front view; B, Back view; C, Lower view. This tool was distorted at the edge where indicated by the arrow by a piece of fossil shell (*Inoceramus*) imbedded in the flint.

basal end. The best formed tool (Fig. 9) is a thin flake of flint, 8·75 cm. (3½ inches) in length, shaped rather like a leaf. The flat side was made by a single blow, and the place where this was delivered is shown by a "bulb of percussion," which always marks the spot where the hammer-stone fell.

The last two of the tools just described (Fig. 8, A, and Fig. 9, A–B) are nearly similar in shape to two tools made by a later race of Palæolithic men, the Mousterians (see Table, p. 28). It is therefore interesting to compare them, as is done in Figs. 8, B, and 9, C–D, because they show well the progress that was soon made in the skilful working of flint. Piltdown Man, like his contemporaries, chipped the flint by direct blows, but later men learned to do finer work by using pressure, either by pressing the edge of the flint with a piece of wood or bone, or by gently tapping a piece of bone or tooth directed to the spot where a flake could be removed. They were thus able to do more elaborate shaping without shattering the flint. As time went on, nearly all the shaping of flint tools was done by pressure from wood, bone, or teeth, and it thus became possible to produce such artistic results as are seen in the arrow-heads of comparatively modern times.

As already mentioned, these stone tools from Piltdown would serve many purposes. They could be used for skinning animals, for scraping the inside of the skin to prepare it for use, and for cutting up the flesh and other soft parts for food. They could also be used for splitting bones and wood, and some were sharp enough to shape both bone and wood by removing small flakes. The only purpose for which they were scarcely adapted was warfare. When the earliest men fought with one another they must have done so without any weapons, except stones and sticks thrown at each other in ape fashion.

For the harder work Piltdown Man would doubtless increase the effectiveness of some of these shaped stones by using with them a bigger stone as hammer.

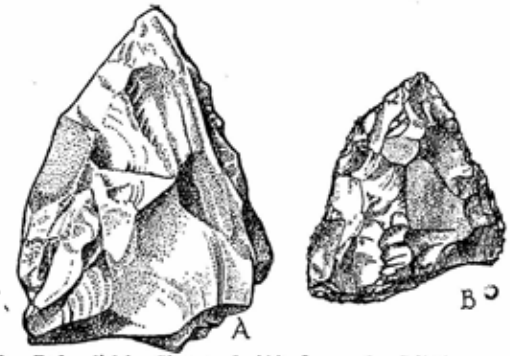


FIG. 8.—Palæolithic flint tool (A) from the Piltdown gravel compared with a similarly shaped flint tool (B) from a Mousterian deposit in the cave of La Chapelle-aux-Saintes, Corrèze, France. This shows the more elaborate chipping practised by the later Palæolithic men. B, *After* M. Boule.

FIG. 9.—Palæolithic flint tool from the Piltdown gravel. A, Front view; B, Side view, compared with a similarly shaped flint tool from an Upper Palæolithic deposit in the cave of Le Moustier, Dordogne, France; C, Front view; D, Side view, to show the more elaborate chipping practised by the later Palæolithic men. (*After* Lartet and Christy.)

We know that he used hammer-stones to pound nuts and seeds, and perhaps to break bones for their marrow, because we found one lump of flint, 13 cm. (5 inches) in length and 7·5 cm. (3 inches) in thickness, bearing fine marks of battering over a large part of its surface.

Piltdown Man would also pick up casually any suitable flint that would serve his purpose for the moment. There are many such flints which impress

FIG. 10.—Flint Borer from the Piltdown gravel, showing the point battered by use.

the collector at once. Those with a point sometimes appear almost as if they had been intentionally chipped by man, but there is not much doubt that they owe their shape to the hexagonal structure of the flint already mentioned (p. 23). One remarkably pointed example is shown in Fig. 10. It is much smoothed by being rolled about in the water, and must have been accidentally broken while being carried along in the current. It would, however, be a good boring tool,

and there are battered marks on its slender point which seem to show that it was used in this way by early men. There is really nothing new among the flint tools which we found in the Piltdown gravel, but one day we discovered a bone tool, which is still unique. I was watching the workman, who was using a broad pick (or mattock), when I saw some small splinters of bone scattered by a blow. I stopped his work, and searching the spot with my hands, pulled out a heavy blade of bone of which he had damaged the end. It was much covered up with very sticky yellow clay, and was so large as to excite our curiosity. We therefore washed it at once, and were surprised to find that the damaged end had been shaped by man and looked rather like the end of a cricket-bat; we also noticed that the other end had been broken across, and we thought it must have been cracked by the weight of the gravel under which it was originally buried. Mr. Dawson accordingly grubbed with his fingers in the earth around the spot where the broken end had lain, and soon pulled out the rest of the bone, which was still more surprising. This piece was also covered with sticky yellow clay, but when we had washed it we found that it had been trimmed by sharp cuts to a wedge-shaped point. The specimen was then taken to the British Museum (Natural History), where Mr. F. O. Barlow hardened and mended it for study. We found that we had a complete tool (Fig. 11). The first question which arose was as to the origin of the piece of bone itself. The only animal large enough to have provided it was obviously a whale or an elephant. We noticed that the structure of the bone was too compact for that of an ordinary whale, and there was a little irregularity on the outer

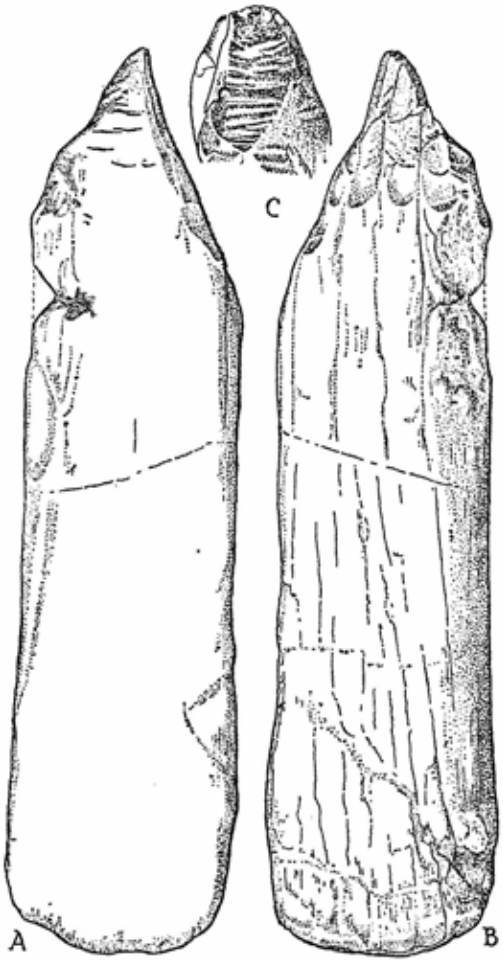


FIG. 11.—Bone tool, from the Piltdown gravel. A, Outer view; B, Inner view; C, Side view of the wedge-shaped tip. The dotted line indicates the shape of the piece of bone which was broken from the outer edge of the original perforation.

surface which showed that it could not have been taken from a whale of any kind. We therefore compared it with the thigh-bone of a very large elephant—one of the two already mentioned as having lived at the same time as Piltdown Man. We placed it in position and found that it agreed exactly in shape. The little irregularity on the outer face of the bone proved to be really the so-called "third trochanter," which in the elephant is very small. Piltdown Man must have hit the thighbone on the outer side and split off a long flake. He may, indeed, have been breaking up the bone to feast on the marrow, and saved this flake because it suited a purpose which he had in mind. He made it into a useful tool by trimming it at both ends and straightening the inner edge. The tool thus made measures 40·5 cm. (16 inches) in length and 10 cm. (4 inches) in width, and its thickness varies from 2·5 to 5 cm. (1 to 2 inches). Its outer face is nearly smooth (Fig. 11, A), and a piece of the outer edge of the bone showing the third trochanter is also smooth. The other face of the bone shows the spongy structure of the wall of the marrow cavity of the thigh bone. The thinner end of the tool is gently and regularly rounded by three rows of small cuts, of which the middle row is terminal and the two bordering rows are inclined towards it. The thicker end, which is wedge-shaped (Fig. 11, C), as already mentioned, is trimmed on the outer face by several broad cuts, some at least 14 mm. (over ½ inch) in width; here and on the opposite face the flatting is broad because it is in the direction of the fibres of the bone. On the side faces of the wedge, where the cuts are across the fibres, they are more numerous and irregular, as might be ex-

pected, being merely little chips. On one edge of the bone near the pointed end there is a small smooth, round groove in an irregular hollow. This groove seems to be part of a round hole originally bored through the bone, and the outer side must have been accidentally broken away, as shown by the peculiar colour of the bone at the spot. A small pit close by, on the inner face of the bone, suggests that the owner of the tool started to make another hole, which was never finished.

This bone tool is unlike anything hitherto known among the handiwork of prehistoric or primitive modern men. We cannot guess for what purpose it was made or how it was used. The rounded end seems to have been the handle, and the heavy wedge-shaped end would be the working part. Whether the round hole was needed during use, or whether it was merely to be threaded for convenience of carrying, is uncertain, but it is clearly worn smooth by a thong, which may have been a strip of skin or a sinew. The fact that the tool is scarcely worn may mean that the hole was important, and that when it was broken the tool became useless. On the whole, it suggests a digging stick, and may have been used for grubbing up roots for food.

Although no wooden tools have been preserved in the Piltdown gravel, there can be no doubt that the man who made the bone tool just described was accustomed to work in wood. The method of shaping the bone suggests work in wood.

CHAPTER V

THE EVERYDAY LIFE OF PILTDOWN MAN

It is not easy to learn about the everyday life of a group of men from relics of them which have fallen accidentally into a river. It is much easier to find out how they lived from things they have left buried in the floor of their dwelling-places. Piltdown Man may have built shelters of boughs in the forest to live in during the summer time, but there is not much doubt that he would go to rock shelters in the winter time and in wet weather. The shape of the surface of the ground round Piltdown has greatly changed since the early part of the Pleistocene period, but within easy reach of our gravel pit there are still low cliffs of sandstone with blocks which overhang shelters, and there must have been similar retreats when Piltdown Man lived there. We know that men who existed at the same time in other parts of England and Wales inhabited rock shelters and caves, because traces of them are found in the earth which has accumulated on the floors of these places. We have not found any such traces in the shelters round Piltdown, and are not likely to do so, because the present hollows are too new.

Many years ago, when my wife and I were walking through forests and crags in the Catskill Mountains in the United States, which were wilder and less accessible than they are now, we were warned not to

enter the rock shelters because they were the sleeping-places of bears, and we might meet a savage mother bear with cubs. Piltdown Men would have to contend not only with bears but also with hyænas, which were then numerous in Western Europe. We know that in Kent's Cavern, near Torquay, a race of men who lived at about the same time as Piltdown Man occupied that cave alternately with bears. Later men in the same cave occupied it only in the intervals when it did not happen to be a hyæna den. In each case there would probably be a struggle for possession. We have learned these facts by digging up the tools, bones, and other relics which became covered up in successive layers of earth accumulated on the floor of the cave. We treat these accidental witnesses to former occupations of the cave as if they were the pages of a book.

When man had settled down in a shelter and perhaps covered the entrance with boughs, he would still have to protect himself at night by making a fire outside to scare away the wild animals. Piltdown Man must have been already acquainted with fire, for we find in the gravel numerous pieces of flint which have been burnt. They can be easily recognized by the peculiar red colour of the oxide of iron which stains them, and sometimes by the way in which they are crackled. These flints may of course have been burnt in forests set on fire by lightning, but we are satisfied that the man himself knew how to make fire when he wanted it. This is shown by the "pot-boilers" which I shall describe later. He would doubtless make sparks of fire either by the wooden drill already mentioned (p. 37) or by striking a flint with a piece of iron pyrites. The sparks would fall on

grass, moss, pith of rushes, or even bits of bark which he had taken care to dry for the purpose. Existing primitive people make fire quickly by such methods even in a damp climate. We have not found any lumps of pyrites in the Piltdown gravel, but they could be easily collected by early man from the surface of the Chalk in the Downs not far away.

Piltdown Man would probably make a fire-place in the same way as do many existing savages, by lining a hollow in the ground with pieces of stone. The larger pieces of burnt flint which we find in the gravel may have been used for such a lining. Some of the existing natives in certain Pacific islands use such a hollow, not only for an ordinary fire, but also for cooking. When the stones have been thoroughly heated, the burning sticks are removed and replaced by little pieces of meat wrapped in leaves, which are covered by earth and left until the heated stones have cooked them. This is almost haybox cookery. Piltdown Man would also make another hollow for the heating, perhaps boiling, of water, and, as pottery was unknown, this would be lined with a piece of skin. A piece of skin, or perhaps a bladder, would have to be used for carrying the water. We know that he was accustomed to heat or boil water, because one day, when I was digging in the gravel at a little distance from the original pit, I found some "pot-boilers" (Fig. 12). These are rounded lumps of flint, which were first heated in the fire and then dropped quickly into the water one after another until the water was sufficiently hot. The strong heating and the sudden cooling of the flint cause it to be reddened and crackled to the centre, and eventually, after short use, to break to pieces. "Pot-boilers" are therefore

easily recognized. They were regularly used by later races of prehistoric men, and were recently in use by various savage peoples. With the " pot-boilers " at Piltdown I found some small pieces of charcoal, which Mr. W. N. Edwards tells me are from oak.

Piltdown Man certainly fed on flesh, for Mr. Dawson picked up a piece of a leg-bone of a deer which was scratched and had been split by a blow

FIG. 12.—Flint pot-boiler, from the Piltdown gravel. The flint has been irregularly split by the alternate heating and rapid cooling, but parts of its original surface are still seen in the smooth patches. The dotted line indicates the probable shape of the original flint.

from a flint, evidently to get at the marrow. We have already seen that the thigh-bone of the elephant mentioned on p. 46 was probably broken for the same purpose. Big game would doubtless be captured in pits, or by means of snares, as it is to-day by the wild tribes of Africa. The digging of the pits in and around Piltdown would be a difficult and slow job, but the rock could often be pulled out in small pieces,

and the earth could be dug slowly by using the shoulder-blade of an animal, such as a horse, for a spade. We know that shoulder-blades were used as spades by men of the Neolithic or New Stone Age. Piltdown Man, however, was evidently a mixed feeder: he ate roots, nuts, and seeds, as shown by the hammer-stone (Fig. 13), about 12 cm. (5 inches) in length, which must have been used for pounding them.

FIG. 13.—Flint hammer-stone, from the Piltdown gravel. The arrows point to the more battered parts, which have been used for pounding food.

He seems only to have broken them up, or to have pulped them, without any grinding to make flour or meal, for we have never found any trace of grinding on the tools or other stones. He could grub up roots by the bone tool which is described on p. 44, or with any other pointed piece of stone, bone, or wood.

For dress, Piltdown Man would have to depend on skins, which he would wear with the fur turned inside; he would be able to cut them easily with some of

the tools we have found, and he appears sometimes to have cut them into narrow strips to be used as thongs. We have already seen that a thong of this kind might be needed to thread through the hole of the large bone tool shown in Fig. 11. He could tie together the smaller skins by means of thongs or pieces of sinew threaded through bored holes, as the natives of Tierra del Fuego did quite recently, and he could also make skin vessels for carrying water. Like the former black natives of Tasmania, who were described by Captain Cook, he may have used dried grass to make bags and nets for carrying his few personal belongings. His various tools and fire-making materials were too precious to be lost or left behind. His drinking-cups were probably bits of skulls or the broken ends of marrow bones.

Finally, it would be interesting to know whether Piltdown Man was accustomed to think about anything beyond his immediate creature comforts—whether, for instance, he felt any curiosity about the world and sky around him, or whether he had any idea of entering on another life after death. We shall see later that his brain, in shape and size, was scarcely inferior to that of modern man, and he could probably speak and express himself at least as well as any of the existing savages. The beautifully regular curve and the symmetry of the broader end of the bone tool already described seem to show that he had some kind of artistic sense. Our ignorance of any burials dating back to his time makes it impossible to form an opinion as to his general beliefs. We know Piltdown Man and his contemporaries only by fragments of the skeleton which have been preserved by accident, not by intentional burials. According to our present

knowledge, burial after death was not practised until a little later in the Pleistocene period, when Mousterian Man had appeared. As we shall see later, one burial of his time has been carefully studied in France, and seems to prove that man had already formed some idea of a future life.

CHAPTER VI

PILTDOWN MAN

HAVING learned so much about the surroundings and way of life of Piltdown Man, we may now proceed to consider the man himself. He certainly was a man, and not a creature half-way between man and ape. He was perhaps ungainly, and may have walked with a shuffling gait, but his brain and skull were essentially human, only with a few ape-like traits which are rarely or never seen in modern man. When Mr. John Cooke, the artist, tried to arrange the flesh and other soft parts on our restoration of the skull, he could not avoid making the portrait altogether human (Frontispiece). Mr. Dawson, indeed, on seeing this portrait, smiled and observed that he thought he could match it in Sussex to-day.

A closer examination of Mr. Cooke's drawing, however, shows that the ear is represented as pointed at the upper end, not rounded, as it is in modern man. This is imaginary, but is based on an observation of the sculptor Woolner, which was discussed by Darwin. In many of us the inturned upper hind edge of the ear bears a little thickened lump which sometimes projects from the edge. As a rule this prominence is short and rounded, but sometimes, as in Fig. 14, it is a markedly pointed projection. An elder brother of the child whose ear is here represented was actually born with the ear flattened out against the head and ending upwards in a similar point. The upper margin

only began to curl over on the third or fourth day after birth, when the projection was directed downwards. There is not much doubt that this is the shrunken and overturned remnant of a point such as is often seen in monkeys. It is now commonly known as Darwin's Point. Whether it survived as an upturned point in the earliest men is uncertain, but it is interesting to note that the fabulous satyrs and Puck,

FIG. 14.—Left ear of a modern boy, two years old, showing the overturned upper point known as Darwin's Point.

which lived a primitive life in woods, are always credited with an ear of this shape.

The Piltdown skull is in many ways different from any other that we know. All the earliest human skulls hitherto discovered show a few striking resemblances to the skulls of apes, some in one way, some in another. That of Piltdown Man is chiefly remarkable for its ape-like lower jaw. Fossils leave no doubt, indeed, that man is descended from ape-like ancestors to whom he owes most of his bodily shape. He is particularly distinguished from all the

apes, not only by the large size of his brain, but also by the relatively small size of his face and teeth, which are no longer of much use for fighting.

Unfortunately we know very little about the apes which lived before the time of man. There were many more kinds of these apes than there are to-day, and they were more widely spread in the warm regions of the Old World. There are now only four kinds of man-like apes—the gorilla and the chimpanzee in tropical Africa, the orang-utan and the gibbon in the southern Asiatic region. It is probable that these do not differ much from the latest fossil apes of old times. We may therefore use the skull of one of them to learn the difference between the skull of man and that of his presumed ape-ancestors. It is usual to select the chimpanzee for comparison because its jaws and teeth are most nearly similar to those of the fossil apes hitherto discovered.

If we look at the skulls of a full-grown chimpanzee and a man in side view, their proportions are specially well seen (Fig. 15). The small and low brain-case of the chimpanzee is in strange contrast to that of the man, which is not only large, but raised above into a beautifully rounded dome. The forehead of the chimpanzee slopes downwards and forwards to a large pair of bony brow-ridges, which form the roof of the eyes in the projecting face. In man, where the eyes are completely below the front of the brain-case, the forehead is vertical, with only a trace of the brow-ridges. It should, however, be noted that when a chimpanzee is newly-born its forehead is like that of man, and the differences develop during its lifetime. In the chimpanzee the middle upper part of the face is flattened, with no raised bridge to the nose, which is

narrow. In man the bones of the bridge of the nose stand out conspicuously and are comparatively broad. In the chimpanzee the lower jaw is long and narrow, and the row of teeth on one side is nearly parallel with that of the other, while the corner tooth (or canine) of each side stands up prominently above the other teeth, working against an equally prominent tooth in the upper jaw. In man the teeth are arranged in a horseshoe-shaped row, and the canines do not

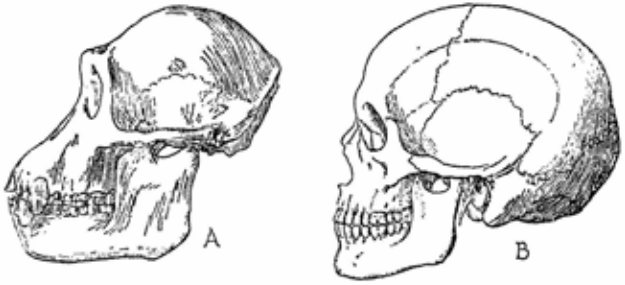


FIG. 15.—Comparison of the skull of a chimpanzee with that of a modern man. A, Left side view of a full-grown male chimpanzee; B, Left side view of the skull of a modern European man.

project above the rest of the teeth. In the chimpanzee the tooth-bearing border of the lower jaw is necessarily very long, and the heavy bony chin slopes downwards and backwards. In the small lower jaw of man the tooth-bearing border is shortened by shrinking, and the bony chin is thus nearly upright, usually with a little forward prominence below. The actual chin of the ape is, indeed, retreating; when living man appears to have a retreating chin, this is due not to the shape of the bone, but only to the fleshy covering of a lower jaw, which is too small to meet the front of the

upper jaw. The jaws of the ape, being so much larger and more powerful than those of man, need larger muscles to work them; the so-called temporal muscle, therefore, instead of spreading over only part of the side of the brain-case, extends to the top, where it is often separated from its fellow of the opposite side by a thin ridge of bone; it also usually extends backwards to a similar ridge of bone across the hind end of the brain-case. Only in young individuals is the skull of modern apes rounded and smooth like that of man.

Remembering all this, it is interesting to look at the broken pieces of fossil bone from Piltdown and see how they may be arranged in a reconstructed skull. They are all hardened and stained brown by oxide of iron, but none of them has lost its original shape during fossilization, or by crushing in the gravel. The colour of the pieces which were first discovered was altered a little by Mr. Dawson when he dipped them in a solution of bi-chromate of potash in the mistaken idea that this would harden them.

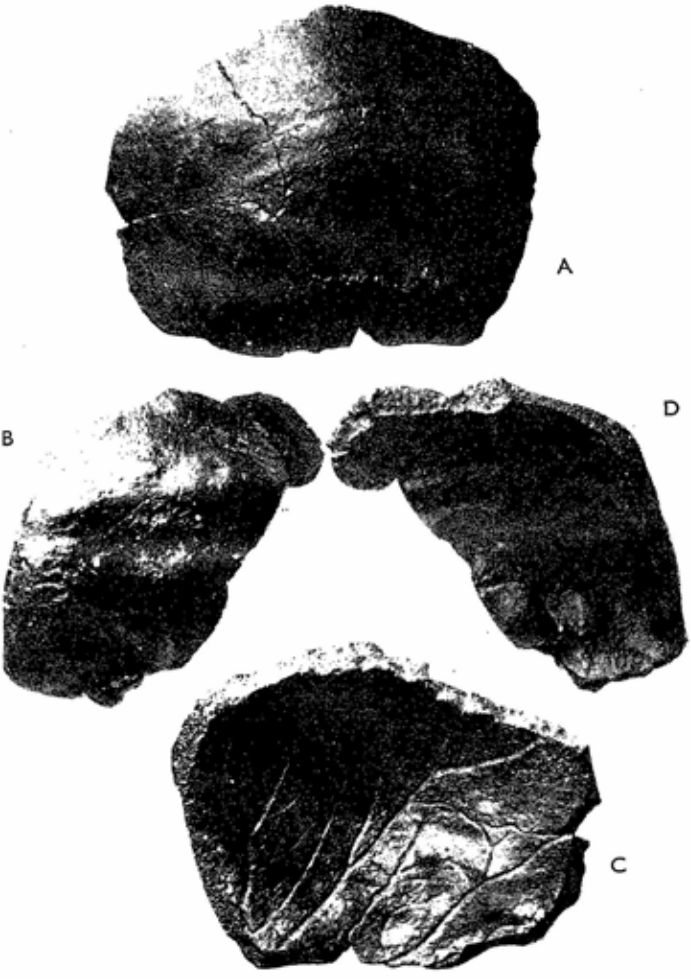
The most striking feature of these bones is their great thickness—sometimes as much as 12 millimetres. The bone which forms the greater part of the side and top of the brain-case (the parietal) is more than twice as thick as that of the ordinary modern man, and is a little thicker even than that of the existing negro and Australian black, which is always thick. In this respect the Piltdown bone also differs from that of the apes, which is comparatively thin.

The thickness of the bones of the human skull probably depends on the extent to which the head is exposed to the sun and weather. Even so long ago as the days of Herodotus this fact had been noticed,

for, in describing the skulls which lay scattered on an old battlefield where Persians and Egyptians had fought, he said it was easy to distinguish those of the two combatants. He wrote:—

> "Here I saw a very surprising fact, which the people of the country informed me of. For as the bones of those who were killed in that battle lie scattered about separately (for those of the Persians lay apart in one place as they did at first, and those of the Egyptians in another), the skulls of the Persians were so weak that if you should hit them only with a single pebble you would break a hole in them; whereas those of the Egyptians are so hard that you could scarcely fracture them by striking them with a stone. The cause of this, they told me, is as follows, and I readily assented; that the Egyptians begin from childhood and shave their heads, and the bone is thickened by exposure to the sun—this, then, is the cause of their having such strong skulls; and the reason why the Persians have weak skulls is this: they shade them from the first, wearing tiaras for hats" (Book III, Thalia).

The bones are remarkable, not only for their thickness, but also for their fine spongy texture, which would enable them to resist heavy blows without cracking—a quality which would doubtless be important at the time when man was beginning a struggle to get the better of things. In modern man each bone consists of three layers—an outer hard layer, an inner still harder layer, and a middle layer of little spaces with thin bony walls, rather like a very irregular honeycomb. In Piltdown Man the outer and inner



THE LARGER PIECES OF THE PILTDOWN SKULL.

A, B, Outer views; C, D, Inner views, showing the markings of the blood-vessels and the great thickness of the bone.

[*To face page* 60.

THE LOWER JAW OF THE PILTDOWN SKULL.

A, Outer view, showing molar teeth in position; B, Inner view; C, Seen from below; D, Seen from above.

[*To face page* 61.

" tables," as they are named, are very thin, and the bone between them is of uniform very fine spongy texture. This peculiar spongy condition is seen in diseased modern skulls, and when the first fragments of the Piltdown skull were found some medical men thought that they must be parts of a diseased skull. Dr. S. G. Shattock, of the Royal College of Surgeons, was especially interested in them, and it was not until he had examined all the fragments repeatedly that he was convinced that they were not diseased. He showed me several diseased skulls in the Royal College of Surgeons which exhibited the same spongy structure, but this structure in them was always in irregular patches, not uniform throughout. Professor A. F. Dixon afterwards showed me other diseased skulls in the anatomical Museum of Trinity College, Dublin, in which the spongy patches were equally irregular. The structure of the bone of the Piltdown skull was seen to be uniform throughout, and was therefore very different. Nothing of the kind had previously been noticed either in apes or in fossil man, but the structure is now known to occur again in the skull of the Chinese fossil Man, *Sinanthropus*, which was discovered in 1929. It therefore gave to widely spread races of early man a skull that was specially adapted to the rough life of the time.

The larger pieces of the skull, which are well seen in the two accompanying plates, are complete enough to be fitted together into two larger pieces. The one large piece shows a corner of the forehead, and the greater part of the left side of the skull, including the socket for the hinge of the lower jaw. The other large piece shows the shape of the back of the head and part of the right side. As there is no place where these two large

typically human, but according to Elliot Smith it is incompletely expanded in three parts which are the latest to grow in the human child. The absence of this growth shows that Piltdown Man was adapted only for a simpler life than that of modern groups of men. He could doubtless speak, for the width of his jaw would allow him to use the tongue freely for forming definite sounds. One of the least expanded parts in the brain, however, is that which governs reasoning and the association of ideas, so that his powers of speech must have been limited. Many of the folds in the structure of the brain have left clear impressions on the bony wall of the brain-cavity, and Keith has observed that some of these suggest an arrangement more ape-like than any seen in modern man. The late Professor J. Symington, however, pointed out that impressions of the brain on the inside of the skull in modern man are sometimes a little blurred by the thin, soft covering which separates the brain itself from the bone surrounding it. The interpretation of the markings on the inside of fossil skulls must therefore be cautious. I sometimes wonder whether the late Sir Grafton Elliot Smith felt these difficulties when he had presented his detailed account of the brain of Piltdown Man to the Royal Society in 1914, because he never completed the paper for publication.

We have already remarked that the left side of the brain in Piltdown Man is larger than the right side; it is indeed unusually large, and projects a little backwards. As the left side of the brain controls the right side of the body, it is reasonable to conclude that Piltdown Man was right-handed, like the majority of existing men. In the apes the brain is usually of almost equal size on both sides, and the animals can

use their right and left hands without preference. Some of them have been observed to be right-handed, but not so habitually, as in man.

Turning to the face, it is interesting to notice that the nasal bones, or those forming the roof of the nose, agree with the heavy skull in being remarkably thick, while the remains of the turbinal bones which are inside the nose are two or three times as thick as usual in modern man. The nasal bones are typically human, but they form only a low, rounded bridge, which shows that the nose would be shaped more like that of a negro than that of a modern European. The face in general must therefore be restored as if it were that of an ordinary man; it would be larger than in a modern man, as shown by the unusual length of the lower jaw. It would, however, be much less projecting than that of any known ape.

The lower jaw is in several ways so remarkably ape-like that some have doubted whether it really belongs to the human skull which was found near to it. They have supposed that at Piltdown we have discovered an entirely new kind of human skull lacking its lower jaw, and an equally new kind of ape-jaw lacking the skull. This would be a startling result indeed to achieve in a single cubic yard of gravel. As the lower jaw contains two grinding teeth which are essentially human, it is more reasonable to conclude that the new skull and the new lower jaw belonged to the same head. We are confirmed in this belief by Mr. Dawson's discovery of a similar grinding tooth, together with two fragments of a second Piltdown skull, in a patch of gravel about two miles away from the original spot.

To see in how many ways this lower jaw from Pilt-

down resembles that of an ordinary ape we must examine it more closely than we have examined the skull. The detailed comparison, however, will be readily understood by referring to the drawings on p. 67 (Figs. 17, 18). They show an outer and inner view of the left half of the lower jaw in a young chimpanzee (A) compared with the Piltdown jaw, which is restored in dotted outline (B), the fossil lower jaw of a man from a river sand near Heidelberg, in Germany (C), and a lower jaw of modern man (D).

The half of the lower jaw which was found at Piltdown is preserved about as far forward as the middle line of the chin. The upper part of the bone in front of the grinding teeth is broken away, but enough of the lower border is preserved to show that the bony chin was shaped as in an ordinary ape, not as in man. If the curve of the lower portion of the chin which remains is continued upwards it shows that the complete bone would be inclined downwards and backwards about as much as in a young chimpanzee. The backwardly-curved lower border tapers to a thin flange with a sharp edge, and the muscles which open the mouth and those which work the little bones under the tongue would be fixed exactly as they are in an ordinary ape, not as in a man. In modern man the vertical bony chin is thick at its rounded lower border, and the muscles which open the jaw are fixed (inserted) to a pair of broad patches on this border. Even in the jaw of the fossil man from Heidelberg, which has a sloping long chin, the lower border is equally thick and rounded, with a pair of patches for the insertion of the muscles. The inner face of the side of the Piltdown jaw is smooth and gently rounded as in an ape, not raised into a lengthwise ridge such as marks the edge

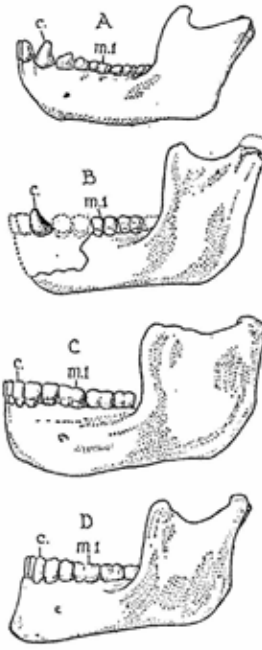


FIG. 17.—Comparison of lower jaw of young chimpanzee (A) with that of Piltdown Man (B), Heidelberg Man (C), and modern man (D), outer side views. *c*, Canine tooth; *m.1*, First molar tooth.

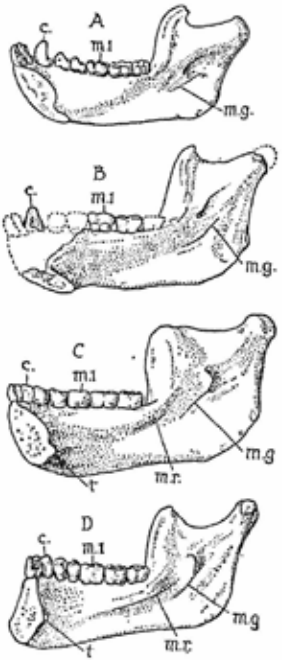


FIG. 18.—Comparison of lower jaw of young chimpanzee (A) with that of Piltdown Man (B), Heidelberg Man (C), and modern man (D), inner side views. *c*, Canine tooth; *m.1*, First molar tooth; *m.g*, Mylohyoid groove; *m.r*, Mylohyoid ridge; *t*, Genial tubercles.

of the floor of the mouth in man. Further back, where the jaw rises into the broad plate of bone (or ascending process), which would originally bear the

rounded hinge for articulation with the skull, there is a tiny streak on the inner face just below the opening which is known as the dental foramen. This is the so-called mylohyoid groove, which is similarly placed in the chimpanzee and orang-utan, but is quite different in man, where it extends downwards from the dental foramen itself. The front edge of the ascending process is remarkably widened for the fixing (insertion) of the great biting muscle (the temporal), and the inner face of the bone is strengthened by a ridge which extends from this, widening obliquely upwards and backwards towards the hinge of the jaw. This arrangement is usual in apes, but is scarcely ever seen in man. It occurs in the fossil Heidelberg human jaw, which is remarkably heavy.

As first noticed by the late Mr. W. P. Pycraft, the strains of the biting muscles on the ascending process at the back of the lower jaw are a little different in the narrow-jawed apes from those of the broad-jawed man (Fig. 19). The direction of the thin plate of bone which forms the ascending process in apes and man is thus not quite the same. In the ape, if a line be drawn along the edge of this process and another line along the row of grinding teeth, continuations of these two lines will meet near the front of the jaw. In man, if similar lines be drawn their continuation will meet, not in front, but well behind the back of the jaw. Corresponding lines drawn through the jaw of Piltdown Man meet behind in the human manner, not forward as in the apes. Although, therefore, the bone from Piltdown is so remarkably ape-like in most ways, the complete jaw must have been wide enough for a human skull, and not on the narrow ape pattern.

The two grinding teeth (first and second molars) which remain in the fossil jaw from Piltdown are typically human, with a deep crown and very thick enamel. They are, however, unusually large, and longer than broad, and the hindmost grinding tooth (third molar) is shown by its root socket to have been

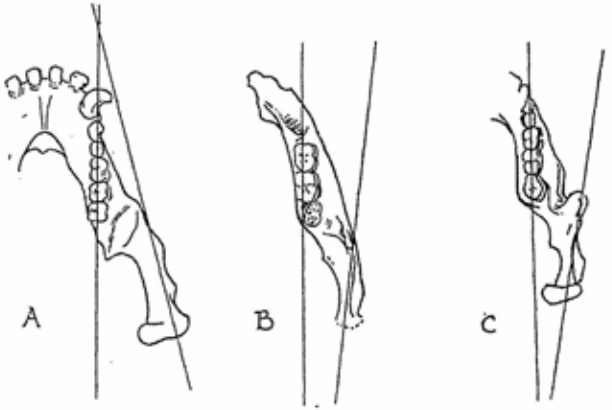


FIG. 19.—Comparison of the right half of the lower jaw of a chimpanzee (A) with that of Piltdown Man (B) and modern man (C), seen from above. Lines drawn along the edge of the ascending process and along the row of grinding teeth converge in front in the chimpanzee, but behind in Piltdown Man and modern man. (*After* W. P. Pycraft.)

nearly as large as the others and elongated in the same way. Similar teeth are known only in jaws of the earliest fossil men and in those of the lowest tribes of existing men, such as the blacks now living in the Australian region. These grinders are considerably smaller in the modern European and in the other higher races of men. The hindmost grinder, indeed, which is commonly known as the wisdom tooth, is

still smaller, and may not even cut the gum. The differences between the Piltdown grinding teeth and those of the modern higher races of men are therefore in the direction of the grinding teeth of apes, which are always relatively large and elongated. Their resemblances to the grinding teeth of some of the known fossil apes which lived before man's coming are indeed very striking. The grinding teeth of Piltdown Man could have developed from the grinding teeth of the earlier apes by quite small changes.

If the outline of the lower jaw from Piltdown be

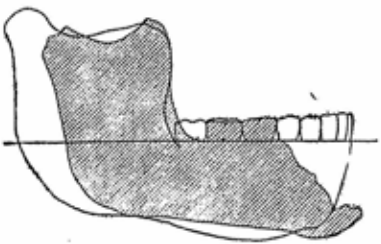


FIG. 20.—Right side of lower jaw of Piltdown Man (shaded), superposed on that of Heidelberg Man, showing the relatively longer chin of the former.

superposed on that from Heidelberg, which is the most ape-like fossil human jaw previously discovered, it will be seen that the first and second grinding teeth are exactly the same in size and shape in both (Fig. 20). The bone in front of these teeth in the Piltdown jaw, however, is much longer than in that from Heidelberg, in which all the front teeth are typically human. The tooth-bearing border of the Piltdown jaw is therefore too long to be filled by human teeth of the ordinary size and shape. When I made my first restoration of the jaw, I had to conclude that the

corner tooth (or canine) must have been much larger than in modern man, and separated enough from the next tooth behind to allow it to interlock with an opposing large tooth in the upper jaw. I noticed, however, that the worn surface of the grinding teeth was remarkably flat and showed that the motion of the jaw during mastication must have been as free as in man, not restricted to a slight side motion, as in apes. I therefore arranged the canine tooth so that it did not project much above the other teeth. When the actual tooth was found it proved to be nearly similar to that which I had imagined, but it was slightly smaller, more pointed, and more upright in the mouth. The enamel on the concave inner face of this tooth was completely worn away down to the level of the gum by the opposing upper tooth, exactly as in apes.

When looked at more closely the ape-like canine tooth is especially interesting; it seems to have been much more extensively worn by mastication than the second grinding tooth. Therefore it probably came into place in the mouth before the latter tooth, and so had been longer in use. In modern man the canine tooth comes into use before the second grinding tooth, whereas in apes the canine tooth is cut after the second grinding tooth. There is thus not much doubt that, although the lower teeth of Piltdown Man so closely resemble those of an ape, the order in which they came up was altogether human.

This conclusion becomes specially noteworthy when we compare the canine in detail with that of the apes and with that of the temporary set in a human child—the so-called milk teeth (Fig. 21). The Piltdown tooth is seen to differ in shape from the canine in all known

apes, whether existing or fossil, by the absence of a little prominence on the inner side of the base of the crown. It also differs in the shortness of its root, which is blunted at the lower end. In these ways it is similar to the temporary canine of the human child.

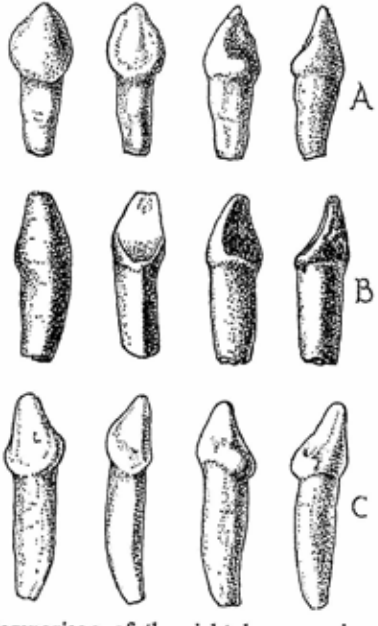


FIG. 21.—Comparison of the right lower canine tooth of a young human child (A) with that of Piltdown Man (B) and that of a young orang-utan (C).

If allowance be made for the hard wear of its inner face and the accidental breaking away of some of the enamel of its outer face, the crown of the Piltdown tooth is almost identical in shape with that of the temporary canine of the human child. The root is

also nearly the same, only a little stronger because the tooth was in active use. It is therefore interesting to notice that in the human child the crown of the canine tooth is often very large compared with the other teeth, and does not rise so far out of the gum as these other teeth. If the crown of the temporary canine of the human child came completely up in the gum like the other teeth, it would project above these teeth, just as the permanent canine does in Piltdown Man. In short, the permanent canine of the fossil man from Piltdown resembles the temporary canine of modern man (Fig. 22). It has not advanced so far from that

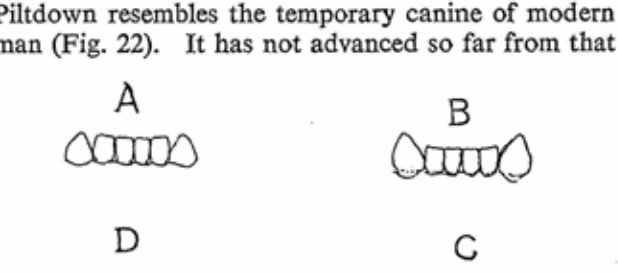


FIG. 22.—Diagrammatic front views of the lower incisors and canine teeth, showing that, if the milk or temporary teeth of modern man (A) were modified by the complete extrusion of the canines (B), these would resemble the permanent teeth of Piltdown Man (C) more closely than do the permanent teeth of any ape, such as the chimpanzee (D).

of the ape-like ancestors as the permanent canine of modern man, which has become more nearly uniform with the other front teeth and never interlocks with its fellow above.

We may therefore conclude that the fossil skull

from Piltdown belonged to a race which had only just become human. Its brain was still a little unfinished, and the powers of speech and reasoning must have been comparatively limited. The face could not be well described as refined, and the neck would not accord with our usual ideas of elegance. His jaws still bore many marks of the ancestral apes which have since disappeared in all human races. He was indeed a man of the dawn, and has been appropriately named Eoanthropus, from two Greek words which mean Dawn-man. His full scientific name is *Eoanthropus Dawsoni*, which recalls his discoverer, Mr. Dawson.

Throughout these pages I have used the word "man" in a general sense. It is not easy to decide whether the Piltdown skull belonged to a man or to a woman; it is, however, supposed that the weakness of the jaw, the feebleness of the muscle-marks on the brain-case, and the small size of the so-called mastoid processes, show that the skull belonged to a woman. If so, the bony brow ridges of the male Eoanthropus may have been larger than those in the skull we have described.

CHAPTER VII

THE ANIMALS LIVING WITH PILTDOWN MAN

We have already remarked that Piltdown Man must have belonged to one of the first human races which appeared in Western Europe. His fossil skull is the oldest piece of a human skeleton hitherto found in this part of the world, and the only possible traces of earlier peoples here are rough bits of flint which are supposed to have been chipped by man. If these are really stone tools they show that man was here earlier than the first mild episode in the Great Ice Age, and actually appeared just before this age began. We have no reason to think that he originated here, because the man-like apes had disappeared from Europe long before, at the beginning of the Pliocene period. They had previously been widely spread in Southern Europe, but unfavourable circumstances seem to have caused them to die out, and the only man-like apes living immediately before the time of Piltdown Man were in the warmer regions of Asia and in Africa. Man must indeed have come from Asia to the West by the same tracks as the many large quadrupeds which arrived at about the same time. In those days the continents of Europe and Asia were more closely connected with Africa than they are at present. Large regions at the eastern end of the Mediterranean, which now have very little rain, must then have been covered with forests and grasslands

able to support great numbers of quadrupeds. These quadrupeds roamed more widely than they do now, and many of them were not restricted to one area as they are at present.

These warm-blooded quadrupeds or mammals include some of the largest and most curiously overgrown animals of their kind. The elephants never before had such large and unwieldy tusks. Some of the deer had horns or antlers so large that it is difficult to understand how they could live comfortably in a forest. The largest cats, most closely resembling lions or tigers, had the most powerful teeth for piercing and cutting flesh that have ever been seen. The feet and claws of these cats were also as good as grappling-irons, even more efficient than those of the lion or tiger. There were overgrowths of the same kind in other mammals of the period, and the extreme size and complication of the brain in man himself must be regarded as another example. Whereas in the quadrupeds these overgrowths were so burdensome that they probably caused the animals to die out, the overgrowth of the brain in man led to a new era in the world of life which he was soon able to dominate. He began to rule indeed when living things had reached their extreme development, and when evolution in most ways had apparently stopped.

It is interesting to look more closely at some of these animals. The elephants were especially large, with their overgrown tusks. The elephants of the present day, when full-grown, vary from 9 feet to 12 feet in height, and their tusks are rarely more than 6 to 8 feet in length. The largest tusk of a modern African elephant recorded by Rowland Ward measures 11 feet 6 inches in length, but this seems to be unique. Two

species of the elephants already mentioned as having lived at the time of Piltdown Man must at times have measured from 14 to 15 feet in height, and their tusks would usually be in a symmetrical pair as much as 10 or 11 feet in length. The tusks still tended to grow larger, and in the mammoths of the latter part of the Great Ice Age they were sometimes 12 feet 6 inches in length. There is one tusk of this size, from the Arctic regions, in the British Museum (Natural History). A skull of the mammoth found in the brick-earth formerly deposited by the Thames at Ilford—also now in the British Museum (Natural History)—has a symmetrical pair of tusks 10 feet 6 inches in length. Some of the mammoth skeletons found in earth of the same geological age, in North America, such as *Elephas imperator*, have an equally large pair of tusks. The tusks must always have been a burden, and they are still felt to be so by the modern African elephant, even when they are not more than 4 or 5 feet in length. Mr. and Mrs. Martin Johnson, who spent several years studying elephants in the African forest, noticed that when an elephant so burdened settles down to sleep it seeks a place where the head can be relieved of the weight of the tusks. One day they saw a male elephant attempt to rest his tusks on the back of his mate. She shook him off repeatedly, and he finally found a prop for them in the fork of a tree.

Most of the rhinoceroses were also unusually large, with the front horn especially long. They were at least as large as the so-called white rhinoceros of Africa, which is now extremely rare, and may soon be extinct. The horn is not preserved with the ordinary fossil skulls, because it consists only of slender fibres

which decay as soon as it is buried. It has been found only on the frozen carcases of the woolly rhinoceros from the mud of the Arctic regions, and on others from a petroleum deposit, in which they have been "pickled," at the foot of the Carpathian Mountains. The horn on the tip of the nose was so long and heavy that the partition of gristle between the nostrils is often partly or completely replaced by bone to strengthen the support. The front horn in the modern rhinoceros is not heavy enough to need such support.

The horses which lived in Western Europe in the time of Piltdown Man included many which were much larger than the ordinary wild horses of more modern date. They rivalled in bulk even the existing dray-horses which have been artificially bred in captivity. A few of the horses found fossil in deposits of the same period in North America are still larger, and exceed in size the largest which have been bred by modern farmers. Their teeth are astonishingly deep, so that they would last during a long life of grinding hard food before they were reduced to stumps.

Although the teeth of hippopotamus from Piltdown are of very ordinary size, many fossil remains of this animal found in other deposits of the same geological age belong to much larger individuals. The size of some of these fossils is so remarkable that they were at first supposed to represent a distinct species, which was accordingly named *Hippopotamus major* (the greater hippopotamus). Now, however, the European fossil animal is considered to be only a variety of the existing African species, *Hippopotamus amphibius*, which flourished exceedingly under unusually favourable conditions. The early ancestors of *Hippopotamus* are known only by fossils from Asia, and there is not

much doubt that *H. amphibius* started in Asia and came west by two different routes, the one leading to Africa, the other to Europe.

Among the fossils from Piltdown we have not found any teeth or bones of wild cattle, but from discoveries elsewhere we know that such animals were abundant at the time in this part of Europe. They were usually of great size, with long and heavy horns. They were larger and stronger than any of the domestic cattle of the present day, and some of them seemed to have survived until historic times in the forests of north Central Europe. They were described by Cæsar, perhaps with some exaggeration, as being as large as elephants. The white wild cattle still preserved in some of the English parks, such as Chillingham in Northumberland and Vaynol in North Wales, are supposed to be direct descendants of these animals.

The bison was also abundant in Europe at the beginning of the Great Ice Age, and, although very variable in size, included some animals much larger than any now living. The bison, however, was still more flourishing at the same time in North America, where there were several species, some with horns no less than 6 feet in span.

It is curious to notice that with the cattle there were no ordinary sheep. These animals did not reach Europe until thousands of years later, when they were brought by men of the Neolithic or New Stone Age, who had already domesticated them. They were originally mountain animals, like their survivors which still live in the highlands of Asia and North America.

Most of the deer were remarkable for the size and weight of their horns or antlers. The great Irish deer

and a few related species sometimes had horns with a span of 9 or 10 feet, and, as these weapons were expanded into broad blades, they were heavier than any seen before or since. The red deer, though small at Piltdown, as already mentioned, was also usually of very large size, with horns that were heavier than those even of the existing North American wapiti.

All these animals, as well as the wild boar, which was likewise abundant, would serve as food for Piltdown Man and contemporary races. They would also furnish good skins for clothing, tents, and various domestic purposes; their bones, too, could readily be worked into tools.

Bears may also have been used for food and clothing. There was the great cave bear which was generally larger even than the present grizzly bear of North America. There was also a smaller animal very like the existing brown or black bear.

The beasts of prey, which shared with man the food offered by these animals of the chase, were also larger and stronger than their descendants which still survive. Very powerful lions were especially abundant in Europe, both in the time of Piltdown Man and during later parts of the Great Ice Age. One skull of a lion from a cave in the Mendip Hills, which is now in the Taunton Castle Museum, measures 13 inches in length, and with it there are many stout bones of equally powerful animals. Towards the end of the Great Ice Age, however, some of these beasts seem to have lived in less favourable conditions, for Miss Nina Layard found, at Ipswich, with the remains of a mammoth, several bones of a lion which showed that it had suffered badly from rheumatism. The lion of course survived in northern Greece until historic times,

when it attacked the horses of the armies engaged in warfare there, as recorded by Herodotus. Since the lion most likely spread westwards into Europe from Asia, it is interesting to notice that the tiger did not come too. The finest tigers that still exist live in Manchuria, in North-Eastern Asia, and the bones of some of them have been found even in the frozen mud of the New Siberian Islands, well within the Arctic Circle.

With the lion, in the early part of the Great Ice Age, there also lived another large beast of prey, which has already been mentioned as having the most powerful cutting-teeth and grasping-claws ever seen in a flesh feeder. This was the so-called "Sabre-toothed Tiger" (Machærodus), of which so few fragments have been found that the animal must have been rather rare. It had the two upper corner teeth, or canines, enlarged into a pair of sabres with a saw-like edge, and the lower jaw hinged in such a way that the mouth could open widely enough to allow these long weapons to pierce the flesh of the prey. The "sabre-tooth" would probably spring on the broad back of an elephant or a rhinoceros, and in that way overcome it as its prey. Many kinds of the "sabre-tooth" lived at the same time in North and South America, where they would also find elephants and other broad-backed animals to feed upon. Although they were so widely distributed, they completely died out everywhere before man had made much progress in altering the world.

Still more abundant in Europe, at the beginning and during most of the Great Ice Age, was a very fine race of the spotted hyæna (*Hyæna crocuta*). It is known to have been living in Western Europe as early

as the time of Piltdown Man, and in England it occupied many caves as dens until the Great Ice Age passed away. The first discovery of one of these dens at Kirkdale, in Yorkshire, in 1821 caused a considerable sensation, but there could be no doubt about the facts after Dr. Buckland, of Oxford, had thoroughly examined them. He noticed in the cave a multitude of broken bones mixed with the remains of hyænas, and felt convinced that they represented the food of these animals. To verify his conclusions he took the leg-bone of a horse from Kirkdale which had been badly broken and compared it with a similar leg-bone which had been used for food by a hyæna in a cage in London. The two bones were almost identical, and had been cracked in the same way to allow the animals to get at the marrow inside. Judging by fossils found in India, the ancestors of the spotted hyæna seem to have lived in that country, whence it spread over the greater part of Asia, Europe, and Africa. It survives now only in Africa, south of the Saharan desert.

Very fine and large wolves were also numerous everywhere. Some of these animals, of course, survived in Britain far into historic times, and they are still abundant in some parts of the European Continent. When referring to Sussex it is interesting to recall a local story of the year A.D. 1000. It was widely believed in this part of England that the world would come to an end in that year, and for some time previously the Sussex people had not thought it worth while to continue their regular destruction of wolves. One Sunday, therefore, in the middle of Worth Forest, they were besieged in the village church by an unusually large pack of these animals, which made the rescue of the congregation a memorable feat.

Besides the larger quadrupeds which lived at the same time as Piltdown Man there was a multitude of smaller animals, in most ways the same as those living in Britain at the present day. There were, for instance, rats, mice, hares, squirrels, moles, weasels, and wild cats. It is curious, however, to find that there were probably no rabbits, which seem to have been introduced by man to this part of Europe from more southerly regions at a later date. A rather larger animal which lived here at the time of Piltdown Man was the beaver, *Trogontherium*, but this did not much exceed the existing beaver in size. A gigantic beaver, *Castoroides*, three or four times as large as the existing animal, was widely spread in North America at the same geological period.

One other small animal must be mentioned, because it suggests the mildness of the climate during the warm episodes of the Great Ice Age. This is the little water tortoise, *Emys orbicularis*, of which remains have been found in the mud of the Norfolk cliffs dating back a little further than the time of Piltdown Man. It survived here even until a later warm interval in the Great Ice Age, for one day in June 1920, when Miss Nina Layard and I were digging out fragments of the skull of a mammoth in a bed of clay at Ipswich, we found part of the shell of this little water tortoise lying underneath. At the present day *Emys orbicularis* lives only in Southern Europe, South-Western Asia, and North Africa.

The large land animals ran riot, so to speak, not only in the regions where man began his career, but also in other lands which he did not reach until later, when he had become very much as we now see him. In Africa, as in India, for example, there were gigantic

buffaloes (*Bubalus*), with long and heavy horns, sometimes measuring at least 12 feet from tip to tip. In Madagascar there were lemurs as large as the largest dogs, and some of them (*Megaladapis*) appear to have lived in water like a hippopotamus. At the present day, of course, the lemurs are little monkey-like animals, living in trees. With the many giant lemurs there were running birds (*Æpyornis*), of which the largest were probably 8 or 9 feet high. Many eggs of these birds have been found, some measuring 9 inches by 13 inches, with a capacity nearly 150 times as great as that of a large hen's egg.

In North America, as we have already remarked, there were elephants, bisons, and beavers even more monstrous than those of the Old World. In South America, where the most characteristic animals now are little armadillos, ant-eaters, and sloths, there were giant armadillos and enormous ground sloths. Animals like the jaguar, which much resembles a leopard, were also larger then than they are now. In Australia some of the kangaroos were so large that they were too heavy to jump, and other pouched animals, rather like the little phalangers now existing in that country, rivalled a rhinoceros in size. In New Zealand there were multitudes of running birds—the so-called moas—of various sizes, but some of them 10 or 11 feet in height. On one of the Antarctic islands there were penguins as large as men 6 feet high.

Man probably met with all these animals when he first reached the lands which they occupied. There was not room for both him and them, and the animals soon died out, as they have done or are doing in Europe, Asia, and Africa. As already mentioned,

man started a new era in the world of life. He eventually domesticated some of these animals and turned them to his own use. Among those which remained wild, he hunted some for his own purposes, and did his best to exterminate others which he felt to be harmful and troublesome.

CHAPTER VIII

THE EVOLUTION OF MAN

At the time when the Piltdown skull was found, the only known geologically ancient fossil human skulls had prominent bony brow-ridges which roofed the eyes in a very large face. These skulls were widely distributed in Europe and Asia, and seemed to belong to one rather variable race which died out everywhere at about the middle of the last Ice Age. It was supposed that modern man originated somewhere quite independently, and then spread over lands where he competed with these more brutal earlier men, and eventually replaced them. I therefore thought the Piltdown skull, with its more nearly human face, might belong to one of the ancestors of modern man which were still being sought.

It thus seemed likely that man had developed from the apes in more than one way. The earliest men with large bony brow-ridges might be regarded as an unsuccessful experiment which eventually came to an end. The earliest men with a forehead more nearly like that of existing men might prove to be the actual ancestors, which needed only a reduction of their jaws and teeth to give them a modern face. The brain and brain-case in each were much the same in shape, and either of them might have become deepened into the modern form of head.

Such a supposition cannot as yet be tested because, as already remarked, we know so little about the apes

which lived just before the time of man. Their fossil remains are very rare, and hitherto we have found nothing but parts of the jaws and teeth. This rarity of the fossil remains of apes can easily be explained. Apes, like men, have always been wary creatures, and have usually escaped the floods, volcanic eruptions, and other accidents which would cause their remains to be buried and become fossils. In Africa to-day it is said that the man-like apes, the gorilla and chimpanzee, rarely die a natural death, but, straggling from their companions when old or feeble, are killed by leopards, which spring upon them from the trees. Thus the least edible parts of the skeleton alone are left, even if circumstances are favourable for their burial as fossils.

When an ape is newly born it is remarkably like a human baby, and the differences between ape and man become greater as the infants grow up. Students of fossils have many reasons for supposing that the young of any animal bears more resemblance to its immediate ancestors than does the full-grown individual. When, therefore, the young of two apparently related animals are nearly the same, it is believed that these young give some idea of what the full-grown common ancestor of the two animals was like. Hence we may conclude that the earliest apes, which were the ancestors both of modern apes and of man, had a comparatively small face, which has grown larger and more prominent in the apes, but changed very little in man, only slightly altered into what we regard as a refined face. Hitherto we have not found any fossil skulls of these ancestral apes, but several specimens of the lower jaw which belongs to them have so short a bony chin that the face must

have been comparatively small, and when it is discovered it will probably fulfil our expectation.

It may now be observed that the Piltdown skull forms a direct link between the supposed earliest ancestral apes and modern man. If we place it between the skull of a young chimpanzee (A), resembling that of an early ancestral ape, and the skull of an existing man (C), as shown in Fig. 23, it is seen in many ways to form a step from one to the other. Although the brain-case of Piltdown is human in size, its low ovoid shape is more like that of the young chimpanzee than that of ordinary man. The relatively large jaw from Piltdown shows that the face of this fossil man was much larger in proportion to the size of the brain-case than it is in modern man, and yet a little smaller than the face in the young chimpanzee. The uppermost part of the face, with no strong brow-ridges, is much the same in all three.

The Piltdown skull, however, still remains unique among the earliest human fossils in the shape of its brow and face. Whereas the upper part of the face is almost modern, the jaws still remain in the ape condition. In all the other early fossil human skulls the forehead slopes downwards and forwards into a pair of bony brow-ridges which roof the prominent eyes in the upper part of the face, while the jaws are nearly like those of modern man. If we place one of these skulls (E) between that of a full-grown chimpanzee (D) (representing the latest ancestral apes) and that of a modern man (C), as in Fig. 23, A–C, it will also be seen to form a step between the ape and human stages. The brain-case, again, although human in size, is shaped more like that of the chimpanzee than that of modern man. The face in general

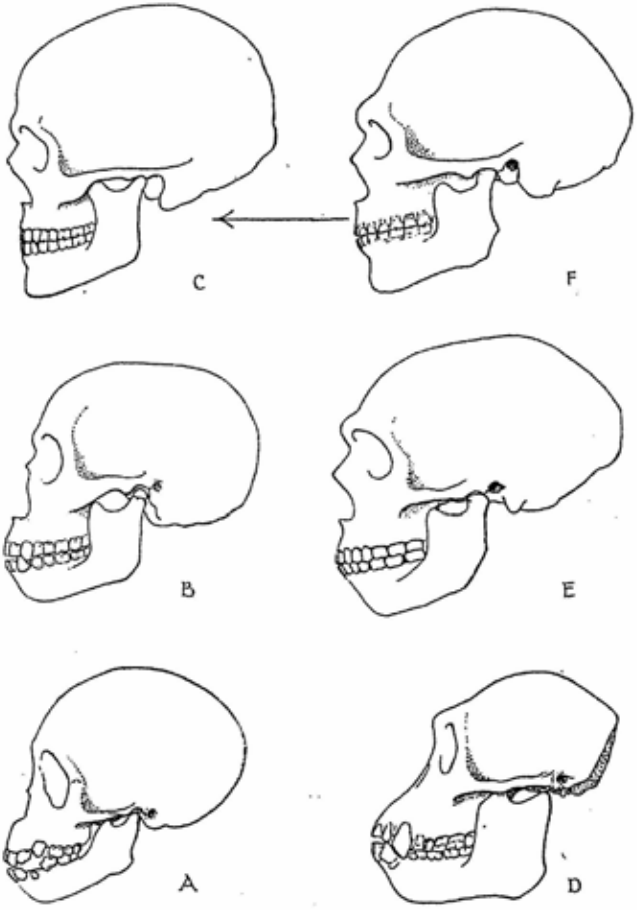


FIG. 23.—Two possible lines of evolution of the human skull. A, Young chimpanzee, representing skull of ancestral ape; B, Piltdown skull; C, Modern man (Aino of Japan); D, Full-grown chimpanzee; E, Neanderthal skull (La Chapelle-aux-Saintes) (*After* Boule); F, Předmost Man (Aurignacian) (*After* Matiegka). The arrow indicates that Předmost Man may have been the ancestor of modern man.

is like that of the chimpanzee, with its sloping forehead and great brow-ridges, but the jaws and teeth are almost completely human. Whereas in Piltdown Man (B) the refinement of the face needs only the reduction of the jaws, the corresponding improvement in the second kind of face is needed, not in the jaws, but in the upper portion. That this kind of skull actually does pass into that of modern man in the later part of the Great Ice Age is shown by the strong remnants of the brow-ridges in the skulls of some of the earliest fossil modern men, like those of Předmost in Moravia (Fig. 23, F), remnants which are scarcely ever seen in the skulls of men at the present day. As we shall see later, recent discoveries in the caves of Mount Carmel, Palestine, actually reveal a tribe of fossil men in which the skull varies from that of a primitive brutal race to that of refined modern man.

In the present incomplete state of our knowledge, therefore, it seems as if the modern human skull had arisen in two different ways. The Piltdown skull may have evolved from one of the primitive small-faced ancestral apes, while the other earliest fossil human skulls may be explained as having evolved from later ancestral apes, in which the face was already enlarged. It often happens that, in a race of animals, some keep throughout life more baby-characters than others, and it is quite likely that for a long period before the time of man some full-grown apes were small-faced, while others were large-faced. However this may be, those who study fossils are all agreed that the first step towards man was made by apes which gave up life among the trees in a forest and started to live habitually on open ground. Just before this time there were two parts of the world—the warmer

regions of Asia and of Africa—where the forests were filled with apes which were more varied and numerous than the apes of to-day. These apes were especially remarkable for their teeth, which were more like the teeth of the earliest men than those of existing apes. They were therefore presumably more like man in other ways than are any of the existing apes.

Hence we may conclude that man originated either in Asia or in Africa. If he originated in South-Central Asia, his beginning may perhaps be accounted for by the uplift of the Himalayan Mountains. During the long period when man-like apes lived in the hot forests of northern India these forests may have extended over the low hills as far north as the plains beyond. Towards the end of the period, in quite modern geological times, there was a curious crumpling of the surface of the earth, which pushed up the Himalayas into a high mountain range. The new mountains thus destroyed a long strip of forest, extending from east to west, and separated off a northern portion. Here the trees would be thinner or eventually destroyed by the colder climate, and any apes stranded among them would have to adapt themselves to the new conditions if they were to survive. They would have to live more habitually on the ground, and their wits would be sharpened by the difficulties of their surroundings. It is therefore not unreasonable to suppose that a race of ground-apes would come into being with brains superior to those of their ancestors. This was pointed out by an ingenious American geologist, Dr. Joseph Barrell, who imagined that a primitive kind of man might soon appear among the communities of ground-apes who were struggling for a new way of life. No

fossil remains of such links between apes and men have hitherto been found in that part of the world, but we must remember that the scientific exploration has hardly been begun. We may, however, note that a single grinding tooth (named *Gigantopithecus blacki*), which is identical with that of a ground-ape, has been found in southern China, and this evidently means that ground-apes did once exist in Asia.

Those who look to Africa as the place of origin of man also suppose that he appeared when some of the apes left the forest to live among the comparatively dry and bare hills. In the caves of Bechuanaland and the Transvaal, Professor Raymond Dart and Dr. Robert Broom have found the remains of apes with brains and teeth more like those of man than the brains and teeth of any existing ape. These animals, of which the first described was named *Australopithecus*, were not much larger than a chimpanzee. They are known by little more than their skulls, but certain markings on the inner side of the brain-case show that that part of the brain which controlled the hind-limbs was unusually large. They therefore seem to have walked upright more habitually than any existing ape, and their arms would thus be free to be used more nearly like those of man. They seem actually to have lived in caves and to have fed more on flesh than the apes of the forest. With their remains, at least, Dr. Broom has found great heaps of the broken bones of small animals which he feels sure are the relics of their food. All these animals are nearly similar to those which live in the same region at the present time, and are not forest-dwellers. Some of them could only have been hunted by the apes if they had worked together in packs, while others must

have been dug out of burrows with the help of some convenient piece of stone, bone, or wood. The cave-apes, however, need not have been restricted to a flesh diet, for there would be numerous bulbs and roots in the surrounding hills which would serve as good vegetable food. The ground-apes of the caves were evidently getting experience of ways of life which we are accustomed to associate with man rather than with apes.

Australopithecus and its relatives are indeed of interest as showing that some of the apes did actually progress in the direction of man and would easily have changed into man if the same progress had continued. They themselves, however, cannot have been the direct ancestors of man because the cave deposits in which their remains are found are not older than the early part of the Pleistocene period, when we know that typical modern man already existed in Africa. They are therefore to be regarded as surviving descendants of those ancestors which for some unknown reason had not continued to progress.

At first sight it seems as if the discoveries which have been made up to date favour the idea of man's beginning in Africa. There is the plausible explanation of the origin of ground-apes in Central Asia, but we have not yet found any of them; there is no explanation, except perhaps overcrowding, of their origin in Africa, but we have actually found them there. We must, however, remember that when a superior animal arises it is likely to displace a less well-equipped predecessor, and crowd it out to some distant place of refuge where it can survive for a time without interference. When the Anglo-Saxons invaded England they found it occupied by small dark

people known as Celts, who were less powerful than themselves. These earlier occupants, therefore, were pushed into the hills of the West, where they now survive in what we call the "Celtic fringe." So it was among species of animals as they came into being one after another during long geological ages. The new ones, starting from the place where they began, pushed away the older ones, which survived until later times only on the fringe of the land which they formerly occupied. It is interesting, therefore, to look at a map of the Old World on which the localities of the known discoveries of fossil man are marked (Fig. 24, pp. 98–99), when it will be seen that all the remains of fossil men which can be described as "missing links" have been found on the southern fringe of Asia and Europe, while the most human apes occur on the southern fringe of Africa. Consequently, even if our present knowledge of fossil man is extremely imperfect, the little we know suggests that South-Central Asia is most likely to have been the region where apes first left the forest and the human race began. On this supposition the very man-like cave-apes of South Africa are explained as having been pushed to an extreme limit from the original centre (line 1 on the map).

It may well be said that, if there is any truth in this idea, we ought to dig up remains of some of the successive races who were on the way from the centre to the remote limits, where we have actually found them. We may, indeed, be so fortunate in our future search, but the deposits in which human remains are buried—such as the little accumulations of dust in caves, the heaps of blown sand and dust on open ground, and the spreads of gravel and earth left by

local floods—are so small that they are readily destroyed by the action of the weather and do not often remain untouched for long geological ages. The longer they are exposed to the risks of weathering, the more likely are they to disappear.

The very primitive men represented by the fossil Piltdown skull were pushed equally far in another direction, to the extreme west of Europe (P on the map), when Britain was still connected with the mainland. Not far from the Piltdown men were others, less ape-like, as shown by a lower jaw discovered in a river deposit near Heidelberg, in Germany (H on the map). This Heidelberg jaw (Figs. 17, 18, C) is unusually heavy for a man, but its teeth are typically human, with the usual very small canines not projecting above the level of the other teeth, and the bone marked by muscles which were arranged in the typically human manner. It reminds us of an ape only in the backward and downward slope of the bony chin. It is a tantalizing fragment because it gives no idea of the shape of the skull itself, which still remains unknown. It shows, however, that two distinct kinds of man were already living in this part of Europe at the time. A little later, as proved by Mr. Alan T. Marston's discovery of two bones of a skull in a pit of brick-earth and gravel at Swanscombe, in Kent, near the mouth of the Thames Valley, a kind of man with a brain-case that was essentially modern was living here.

The earliest ape-like men which were pushed to the south-eastern fringe of Asia (line 2 on the map), and perhaps also to a line crossing Africa just south of Victoria Nyanza, were in some ways very different from the Piltdown race which took refuge in Western

Europe. They are not only widely spread, but are definitely followed by successive groups of men in which the skull passes gradually from the low-domed ape-pattern to the high-domed man pattern. The first of these was discovered by Dr. E. Dubois, in 1891, in a river gravel in the island of Java, which was united to the mainland of Asia in recent geological times. Dubois collected only the top of a skull, a few teeth, and a thigh-bone; but more recently Dr. R. von Königswald has found better-preserved skulls, including parts of the upper and lower jaws. Dubois originally named this fossil man *Pithecanthropus* (Ape-man) *erectus*, because the skull had some of the peculiarities of a man and some of an ape, and the thigh-bone which he supposed to belong to it showed that the man had walked upright. The skull of *Pithecanthropus* is indeed remarkably intermediate in size and shape between that of an ordinary man and that of an ape. Whereas the bulk of the brain in the largest known ape—the gorilla—is 630 cubic centimetres, and that of the smallest known human brain in an existing Australian black woman is 930 c.c., the female *Pithecanthropus* has a brain of 730 c.c., and the male of the same fossil man has a brain of 950 c.c. The brain-case, though in some ways shaped like that of an ape, is distinctly human, and would be balanced on an upright backbone in the human manner. At the same time, the face is so large and projects so far forwards that the eyes need a bony roof. The forehead, therefore, is not upright, as in a man, but slopes gently downwards and forwards into a pair of large bony brow-ridges like those of an ape. The bony chin of the lower jaw, though bearing marks of muscles arranged like those

of a man, is not upright, but slopes gently downwards and backwards almost as much as that in an ape. The canine teeth are unusually large and prominent, and must have interlocked like those of the apes and those of Piltdown Man, while the grinding teeth, though of human pattern, have ape-like proportions. In the same geological deposit as the skulls there are a few small chipped stones which may perhaps have been shaped and used as tools by *Pithecanthropus*.

The second "missing link," which was pushed to the south-eastern border of Asia, must have been very like *Pithecanthropus*, though it had lost some of the most ape-like characteristics. The first discovered indication of it was a peculiar human grinding tooth found by Dr. Birger Bohlin, in 1927, among the broken bones of animals in the hardened mud of the floor of a cave at Chou-kou-Tien, in a range of hills about 30 miles from Penkin. Dr. Davidson Black, a Canadian, recognized that the tooth belonged to a new kind of fossil man, which he named *Sinanthropus* (China man) *pekinensis*. In 1929, Dr. W. P. Pei, of the Geological Survey of China, discovered the greater part of a skull of this fossil man in the same deposit at Chou-kou-Tien, and in later years he found some portions of other skulls and jaws, which nearly complete our knowledge of the head. The brain-case of *Sinanthropus* is almost identical in shape with that of *Pithecanthropus*, but the bulk of the brain itself seems to have been a little greater, averaging 1,000 c.c. The forehead of *Sinanthropus* also slopes less gently forwards and is nearly as prominent as in some modern men; but there are still very large bony brow-ridges to roof the projecting eyeballs. The

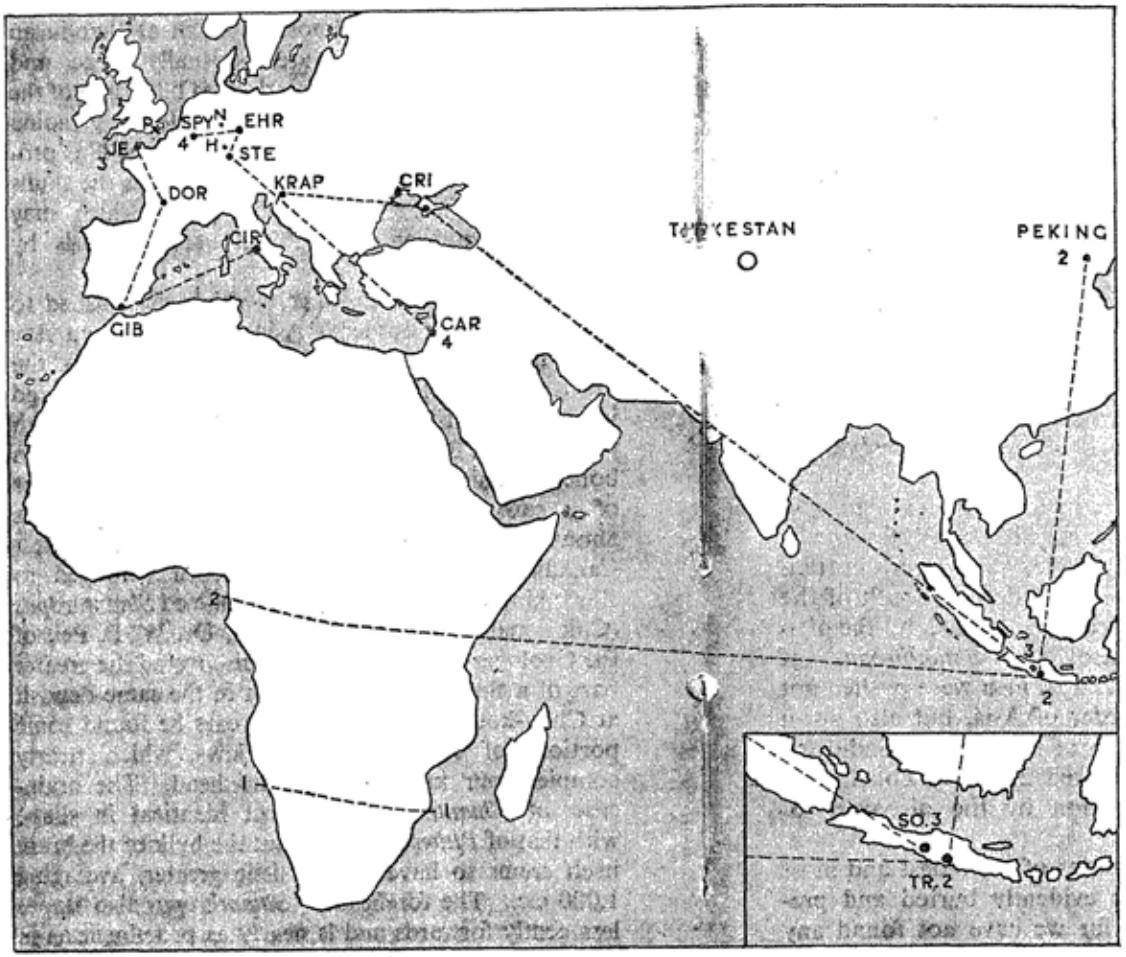


FIG. 24.—Map of the Old World, showing the possible centre of origin of Man (O), surrounded by successive waves of ancestors progressing towards modern man. *1*, Farthest limit of the most man-like apes; *2*, Farthest limit of the most ape-like men (its African limits not yet quite certain); *3*, Farthest limit of fossil men, with ape-shaped skull, but a brain as large as that of modern man; *4*, Farthest limit of fossil man, with a brain-case raised as in a modern man, actually evolving into the modern human skull.

Abbreviations:—

Car,	Mount Carmel.
Cir,	Monte Circeo.
Cri,	Crimea.
Dor,	Dordogne.
Ehr,	Ehringsdorf.
Gib,	Gibraltar.
H,	Heidelberg
Je,	Jersey.
Krap,	Krapina.
N,	Neanderthal.
P,	Piltdown.
So,	Solo River.
Ste,	Steinheim.
Tr,	Trinil.

face and jaws are also nearly similar to those of *Pithecanthropus*, but the upper and lower corner teeth, or canines, do not interlock. According to Dr. Black, *Sinanthropus*, indeed, evidently belongs to the same early human race as *Pithecanthropus*, only it is a little more advanced. Nothing is definitely known about the bones of its body, but a few fragments found in the same deposits as the skulls are almost identical with the corresponding parts of modern human bones. *Sinanthropus* seems to have lived in the cave where its remains were found, because there are traces of fires, and some of the broken bones of animals are burnt, as if they were relics of food. It should be added that there are also roughly chipped pieces of stone which were probably used as tools. His mode of life was therefore at least as advanced as that of Piltdown Man.

The corresponding ape-like man, *Africanthropus Njarænsis*, which is recognized by Professor H. Weinert and Dr. L. S. B. Leakey among certain fragments of skulls found in a lake deposit south of the Victoria Nyanza, in Africa, is supposed by them to have been almost identical with *Sinanthropus*. If they are right, the earliest fossil men were pushed not only to the southern border of Asia, but also down Africa, to a line well south of the Equator, indicated by dots on the map (marked 2). This conclusion, however, needs confirmation by the discovery of more satisfactory fossils.

These fragmentary remains of the oldest and most ape-like fossil men were evidently buried and preserved by accident. So far we have not found any evidence that the earliest men intentionally buried their dead. African natives have told travellers that

when a monkey dies, its companions merely leave it and move to another spot, but that when a gorilla or chimpanzee happens to die in an ape community, its companions throw the body into a hollow and bury it under a heap of branches and twigs. Mr. F. W. H. Migeod, however, who has travelled widely in the African forests, tells me that he has never been able to verify this statement. According to our present knowledge it seems most unlikely that either the most man-like apes or the most ape-like men ever buried their dead.

We know more about the fossil men of the next higher grade (line 3 on the map) because they sometimes buried their dead in rock shelters and caves, where the bodies would be least liable to disturbance. These burials are found only in deposits of a geological period a little later than those to which we have already referred. The first skeleton was found by accident, in 1856, in a cave in the Neander valley, or Neanderthal, near Düsseldorf, in Germany (N on the map). Unfortunately, it was dug out roughly, by workmen who preserved only the top of the skull and a few of the larger bones, which are now in the Lower Rhine Museum at Bonn, in Germany. At the time of the discovery it startled students of fossil man, who recognized that the bones, though human, showed more resemblances to those of an ape than any that had previously been seen. Some old-fashioned human anatomists even tried to explain it as belonging to a half-witted monstrosity. It was only later, when other skeletons of nearly the same kind were discovered under similar conditions, that the fossil was recognized as belonging to a prehistoric race which was more ape-like than modern man. From the

place of the original discovery it was named Neanderthal Man, or *Homo neanderthalensis.* Afterwards it was proved to have lived at the time when man used stone tools like those found in the rock shelters of Le Moustier, in the Dordogne, south-central France, and thus is often referred to as Mousterian Man, *Homo mousterensis.*

The first really well preserved skeleton to be dug out by scientific men was found in 1908, by three archæologists, the Abbés A. and J. Bouyssonie and Bardon, in a little cave near La Chapelle-aux-Saintes, Corrèze, central France. This was doubtless an intentional burial, for it lay in a hole which had been specially dug in the floor of the cave. It proved to be of great interest because it showed that man at so remote a time had already formed some idea of another life after death. Surrounding the skeleton were stone tools evidently to be used in the new life, and also food for the journey thither. This food consisted chiefly of the leg of a bison, which had been buried while it was still covered with the flesh, as shown by the position of the smaller bones. The skeleton is now in the National Museum of Natural History in Paris, where it was studied and described by Professor Marcellin Boule in 1913. When Professor Boule showed it to me, some years later, he pointed to a broken hole in the skull and told me of the curious accident which first brought it to the notice of the archæologists who dug it up. When they had removed most of the earth containing bones and stone tools from the floor of the cave and thought that they had nearly reached the end of their labours, they returned to examine once again the cleared surface. They found a small boy playing in the cave,

and just as they arrived he kicked what he supposed to be a smooth pebble sticking out of the earthy floor; the Abbés recognized that this was a piece of bone, and it led them to a further digging which revealed the grave and its contents. The smooth pebble was, indeed, a projecting bit of the brain-case.

Other almost equally well-preserved skeletons of both old and young persons, which must have been intentionally buried, have since been found in rock shelters in the Dordogne, south-central France, and we now have a good idea of the special characteristics of the Neanderthal or Mousterian race. One skeleton found at Le Moustier is especially interesting because, when it was dug up, a beautifully chipped large stone hand-axe was clearly held in one hand—another indication of the belief that tools would be needed in a future life.

The remains of similar men hitherto discovered in other localities are almost restricted to imperfect skulls, but they are very widely distributed. They range from the Solo River in Java, to the Crimea in southern Russia, to Krapina in Croatia, the Neapolitan coast in Italy, and the Rock of Gibraltar. They show that the skull of Neanderthal Man did not differ much in shape from that of *Pithecanthropus* and *Sinanthropus*, but had a considerably larger brain-case. The bulk of the brain in the fossil skulls in fact varied from about 1,200 c.c. to 1,650 c.c., and was therefore equal to that of the average modern civilized man. The brain, though great in quantity, may have been low in quality, for studies which have been made of the brain in leaders of modern men have shown that size is not of so much importance as internal structure.

The working of brain-power, indeed, still remains a mystery.

The skull of Neanderthal Man, as shown by the fossil skeletons from France, is also remarkable for its large size compared with the rest of the skeleton. This man would scarcely exceed 5 feet in stature, but his head would be extraordinarily large and heavy. Like his predecessors, he would have a very prominent face, but the bony chin is more nearly vertical, and the teeth do not differ much from those of the lowest races of modern man. The backbone is rather stronger and a little shorter than is usual in modern man. The arm is longer than that of modern man, and is also a little ape-like in the arched shape of the bones of the fore-arm. The thigh bone is not straight like that of modern man, but is bent and rather stout, recalling that of the ape, and the shin is comparatively short. Altogether the skeleton, though typically human, bears more resemblance to the skeleton of an ape than does the skeleton of any existing man.

It is interesting to add that Neanderthal Man not only agreed with the lowest existing men in his primitive religious belief, but also seems to have shared with some of them the practice of cannibalism. Dr. Gorganovic-Kramberger, who discovered the remains of Neanderthal Man in the rock shelter at Krapina, Croatia, was convinced that most of the broken and burnt bones of men, women, and children were the relics of human feasts. Dr. R. von Konigswald, who studied eleven skulls of Solo Man, evidently also of the Neanderthal race, from a deposit near the Solo River, in Java, pointed out that these skulls must have been broken by man in order to use

the brain as food. All the skulls were broken in the same way as those more recently collected by the headhunters of Borneo, who feasted on the brain.

The recognition that the brain-case of Solo Man in Java, *Javanthropus* (Java Man) *solœnsis* of W. F. F. Oppenoorth, is nearly the same as that of Neanderthal Man in Europe is especially important because it shows that Neanderthal Man belongs to a later geological period than *Pithecanthropus*. Theoretically this should be so. The remains of *Pithecanthropus* and of Solo Man fortunately occur in river deposits in the same valley: the first near Trinil, the second near Ngandong. The geological structure of the valley is simple, and the river deposit containing *Pithecanthropus* is distinctly older than that containing Solo Man.

As might be expected, the widely distributed skulls of Neanderthal Man vary in many details, but most of the earlier ones are of much the same general depressed shape. Some of them, including especially those of later date, seem to have varied chiefly in the deepening of the brain-case and a reduction in size of the bony brow-ridges, thus becoming more and more like the skulls of typical modern man. This approach to modern man was noticed first in one of the two skeletons of Neanderthal Man which were dug up in 1885 in the rock shelters of Spy, near Namur, in Belgium. It has since been noticed in skulls from Weimar and Würtemburg, among other regions, and it is most striking in the fine series of skeletons which were found, between 1929 and 1937, by Professor Dorothy Garrod and Dr. Theodore D. McCown in caves on the western

side of Mount Carmel, in Palestine. If a line be drawn connecting all these localities (No. 4 in the map, Fig. 24, pp. 98–99), it will be seen that it is a little nearer to the presumed centre of human evolution in Asia than the line (No. 3) connecting the localities where the most ape-like skulls of Neanderthal Man have been found. It thus represents the latest stage in the development of Neanderthal Man, and marks the beginning of the human race as we know it to-day.

The skeletons from the caves of Mount Carmel evidently represent intentional burials. There is not much doubt that they belonged to people who were living together at the same time in some of the caves where they were found. They were studied and described in detail by Dr. McCown and Sir Arthur Keith in a beautifully illustrated volume which was published by the Oxford University Press in 1939. Some are of distinctly Neanderthal pattern, others are typically modern human, and the rest fill the gap between these two extremes. These people, indeed, either lived in the region where modern man came into being, or were not far distant from it. Most of the stone tools which they left behind in the floor of the caves where they lived were of the same kinds as those which typical Neanderthal Man used in Europe, but a few others resemble those of a later period in Europe when the earliest modern man—the so-called Aurignacian—took the place of the Neanderthalian. The skeletons are mixed, and so are the tools. Everything points to the conclusion that in Palestine we are approaching the source of the human race as we know it to-day.

The latter conclusion is especially interesting

because the discoveries of the American traveller Dr. Raphael Pumpelly, and his companions, seem to show that man began real civilization in South-Central Asia. It was there that the men of the later Stone Age (the Neolithic) evidently started to domesticate animals and to cultivate crops. It was thence, of course, that in much later times well-organized communities began to move in successive migrations towards Europe.

It is curious that, so far as we know at present, none of these later ape-like men reached Africa. A modern kind of human skull from a cave in Northern Rhodesia (the so-called *Homo rhodesiensis*) has a bony face very like that of Neanderthal Man, but this may be the result of disease.

There were several races of the first modern men in Asia who appear to have been unable to make much progress in the art of living. Some of these migrated to Australia and Tasmania, where they have lived, until historic times, without any appreciable change. Others probably passed into Africa and settled down to a life which was little more advanced. Survivors of some of these early settlers still live in desert regions, such as the Kalahari, and the thicker forests, such as those of the Congo. Others, again, travelled to Alaska over a land bridge which blocked the present Behring Straits but has now disappeared. We feel sure of this because they settled at first at one place near Fairbanks, in Alaska, where they left behind stone tools exactly like those which they previously made and used when they dwelt in the Gobi Desert of Asia. From Alaska they eventually spread over the greater part of the American Continent, where they continued to live the wild life as hunters until they were disturbed

in historic times by invaders, chiefly from Europe. All these peoples, as well as the emigrants to the remote Pacific Islands, including New Zealand, remained in unprogressive isolation, while civilization continued to advance in Europe.

CHAPTER IX

SUMMING UP

WE know from geology that the present world of life is the outcome of a long series of Nature's experiments which have lasted over millions of years. The plants and animals with which we are familiar in the world of to-day were, indeed, not created all at once, but came into being group after group, one after another. They are the successful descendants of a multitude of plants and animals which were good enough for their day, but were not suited to be more than temporary stages in the progress of life. At first, living things were restricted to the waters of the earth—the shallow seas, lagoons, lakes, and rivers—and it was only later that some of them began to leave the water and become adapted for existing in air. The whole world was henceforth soon occupied by living things which gradually suited themselves to the varied new conditions open to them.

When four-footed backboned animals first began to live on land, they were cold-blooded like the fishes from which they had sprung. Although they breathed air by lungs, they still began life in water, breathing by gills, as do tadpoles to-day. They were, in fact, very similar to the newts and salamanders which now take their place. They could live only in the neighbourhood of water, but they were obviously placed in favourable circumstances, for they spread all over the world, from the Arctic regions, in the north, to Australia in the south. As in their fish-ancestors, the teeth in

most of them had a very complicated structure, showing, when cut across, a compact mass of folds of tooth substance arranged rather like the convolutions seen on the surface of the human brain. They are therefore named Labyrinthodonts (labyrinth-toothed). For long geological periods they were the only backboned animals on land; but they never did more than crawl about in a shuffling way, and their simple five-toed legs never changed except by the occasional loss of one toe on the front foot. They fed on little soft-bodied animals and fishes, and do not seem to have varied their diet by eating plants. Both in the water and on the land there were creatures like worms, snails, scorpions, and wood-lice, and on the land there were also insects, notably cockroaches.

Most of the backboned animals might be described as dreamy dwellers in swamps, with a brain little better than that of fishes; but some kinds increased in size as time went on, and towards their end the large crocodile-like head became no less than 3 feet in length. The head was then about one-third the complete length of the animal—inconveniently large for life on land. These latest creatures probably therefore returned to the habits of their ancestors, and spent most of their life swimming in water. This was the first great experiment in backboned life on land. The animals learned to breathe by lungs and to crawl on hard ground. They were handicapped by having to begin life in water, where they breathed by gills.

In the next stage some of the smallest of the salamander-like creatures changed their habits and were stranded in deserts, where they had to travel long distances in search of food. They thus became more alert and active, with stronger legs, and depended less

on life in water. They had, indeed, evolved to the level of animals which we call reptiles, and lived very much like the lizards of to-day. The body still tapered gradually into a stout tail, but the very much stronger legs in the different groups became specially fitted for the several ways of life. These legs were well formed either for walking, running, springing, jumping, swimming, or even for flying. The teeth now were not always simple cones, but were varied in shape in the different groups, so that greater variety in the feeding was possible. Some of these creatures probably ate only plants, thus beginning a new era in which animals no longer fed only upon one another. These four-footed reptiles also flourished exceedingly, and spread to every part of the world. They occupied every sphere—land, rivers, lakes, seas, and air. Animals of each group prospered, and in the end reached great size. Some of the last of them—the dinosaurs, which are now familiar even in comic pictures—were as much as 100 feet in length. So far as we can judge from skeletons, however, they remained just reptiles with cold blood and scarcely any brain-power. The plants by which they were surrounded were good enough as food for the few among them which ate vegetation, but these plants belonged to groups which the higher animal life of later times would not have found attractive or nourishing.

Such was the second great experiment in peopling the world with air-breathing backboned animals. It was an adventure during which the muscles became stronger and more complicated, to work limbs which were suited to very varied conditions of life. It was handicapped only by the coldness of the blood and the smallness of the brain, which did not progress.

Before the age of reptiles had passed away a few of the smallest of these animals were provided with a better kind of heart, which caused their blood to become warm. They were thus more nearly independent of the temperature of the air surrounding them, and the warm blood soon helped the brain to improve in quality as well as in quantity. In this way arose the ancestors of the warm-blooded quadrupeds, or mammals, and of the birds. In the earliest and some of the lowest of these mammals the tail continued to be merely the tapering end of the body, as it is still, for example, in the kangaroos, which use it as a balance when jumping. In most of the mammals, however, the tail diminished into the appendage hanging on the body behind, with varied new uses in the different groups. In the cats and dogs it serves to express the emotions; in the rats and mice it is a delicate feeler when running through dark passages; in the New World monkeys it is almost an extra hand for hanging on trees; in hoofed animals, such as the horse and cow, it is used to whisk flies from the delicate skin; and in the sheep of certain Eastern countries it serves as a store of fat, which may be important when food is scarce. The legs show improvements on those which were good enough for the reptiles; the bones are well finished at the ends, so that the walking legs lift up the body and support it even when the animal is at rest. The teeth in many groups have especially changed for more varied uses, and perfect grinding teeth appear for the first time. Animals which had evolved in this way carried on the third great experiment in occupying the earth.

So long as the first little ancestors of the mammals lived with the flourishing reptiles, they were com-

paratively insignificant and probably fed on insects and the eggs of the reptiles themselves. In due time, however, the reptiles in some mysterious way reached the end of their overpowering place in the world of life. A great change then occurred in the vegetation of the earth. Water-reeds and grasses appeared for the first time in abundance everywhere, and modern kinds of trees with a multitude of irregular branches began to form most of the forests. This new vegetation made it possible for a larger proportion of the mammals to be plant-eaters. A few of the smaller ones began to live in the trees, but most of them seem to have started their career in the reedy swamps. When the grasses spread more widely over the plains the swamp creatures were tempted in increasing variety to start a new life on hard ground. Thus arose quadrupeds like horses, rhinoceroses, cattle, antelopes, deer, camels, and elephants, all with hoofed feet, and with grinding teeth which would last for a long lifetime of eating hard and dry food. As ages passed, many of these vegetable-feeders gradually increased in size, and their brains also became comparatively large and more complicated. The accompanying flesh-eaters, such as lions, leopards, and wolves, likewise increased in size and brain-power. In the end, however, the brain-growth in both these groups stopped and remained on the level which we find in these quadrupeds to-day.

The little five-toed mammals which at first took to the trees seem to have remained there feeding on soft food, such as insects, grubs, fruits, and leaves, and spending their whole time among the branches. For such a scrambling life all five fingers and toes were needed, and very little change could be expected in the

body and limbs, which were already so well adapted for their surroundings. They began as animals which we should now call lemurs, then advanced to the rank of monkeys, and finally ended as man-like apes. As time went on, some of these tree-dwellers also gradually grew larger, and their brain improved like that of the other mammals which lived on the plains and in the swamps. In them, however, the brain became even more complicated and adapted for more varied experiences. Eventually, as fossils lead us to suppose, when some of the larger apes left the trees to live on the ground the brain increased and improved still further, and the ancestor of man was well on his way.

In these circumstances it is interesting to notice how man came into being at the period when the world was exactly adapted to his needs. Among the quadrupeds we have mentioned there were grazing animals of which the flesh was more suitable for his food than that of any animals which lived at earlier periods in the Earth's history; there were also the birds with flesh which was equally nourishing. The various grasses on which the grazing animals fed included some producing seeds which might soon become his staple food. The newly flourishing herbs furnished both leaves and seeds which would also add to his diet, and many of the forest trees bore varied kinds of fruit which would be more nourishing and attractive than any which had existed before. The Age of Man had indeed truly arrived.

Finally it must be remarked that man is not only the natural end of the procession of life which is revealed by fossils: he seems to have come into being in accordance with the rules by which the various animals have succeeded each other during geological ages.

When a new group of animals appeared it was not descended from a single pair of the ancestors which preceded it, but from several ancestors approaching it in the same or in different ways. For example, the one-toed horses of the present day, which are descended from three-toed ancestors, seem to have evolved from those ancestors at the same time in more than one place, probably both in North America and in Southern Asia. Similarly, as remarked in Chapter VIII, the Piltdown Man in Europe and *Pithecanthropus* in Asia seem to have evolved independently from two different sets of ancestral apes, the refinement of the face in the one beginning with the forehead, that of the other beginning with the jaws. Again, as shown in the present Chapter, when a race of animals is traced through successive geological ages some of them gradually increase in size until the largest are the latest. It is therefore significant that man and some of the existing gorillas, which are the latest members of the race called Primates, are also the largest. Furthermore, as already stated in Chapter VIII, when a later animal develops beyond its ancestor it often shows more traces of the structures of that ancestor in its early youth than when fully grown. It is therefore noteworthy that modern man has the canine teeth resembling those of an ape only when he is a young child, whereas Piltdown Man, a presumed ancestor of modern man, still had canine teeth of the ape pattern even when he was full-grown. These are small indications, owing to the fewness of the known fossils, but they all point in the same direction, and confirm the idea already mentioned, that man is closely linked with the animal world and has come into being in the same way as the rest of living things.

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